

An investigation of encoding and retrieval  
processes in children's false memories in the  
DRM paradigm.

---

A thesis submitted in partial  
fulfilment of the requirements for  
the Degree of  
Master of Science in Psychology

By

Marissa J. Blakeley

---

University of Canterbury

2006

## Acknowledgements

I would firstly like to thank the communities of the following six schools which willingly agreed to take part in this research: Kirkwood Intermediate School, Branston Intermediate, Shirley Intermediate, Chisnallwood Intermediate School, Cobham Intermediate School and Christchurch South Intermediate. Thank you to the principals, teachers, and Boards of Trustees of these six schools, and to the parents of the participants for allowing their children to participate in this study. I would like to say a huge ‘thank you’ to all the students who participated in this research, as I could not have done it without you!

I would especially like to thank my supervisors, Dr Ewald Neumann and Mr Paul Russell, for their guidance, patience and help. It is very much appreciated. Thank you to my research assistant, Jo Vallance, and all my fellow psychology post-graduate students for their encouragement and support.

I would like to thank my extremely supportive and loving family. In particular, thanks to my mother for designing the additional original pictures and for help with proof-reading. I would also like to thank all my wonderful friends for always being there for me.

# TABLE OF CONTENTS

TABLE OF CONTENTS.....	iii
LIST OF TABLES .....	v
LIST OF FIGURES .....	vi
Abstract.....	7
1.0 INTRODUCTION .....	8
1.1 False memories and the DRM paradigm .....	11
1.1.1 Suggestibility of memory errors: eyewitness memory research.....	13
1.1.2 The false memory phenomenon .....	13
1.1.3 Impossible memories.....	14
1.1.4 The DRM paradigm .....	14
1.1.5 Summary.....	16
1.2 Reducing false memories .....	16
1.2.1. Encoding processes in the reduction of false memories .....	18
1.2.2. Retrieval suppression mechanisms in the reduction of false memories ..	19
1.2.3 Overview of encoding and retrieval processes and relevance to the current study .....	21
1.3 Why distinctive information reduces false memories in adults: two accounts to explain the reduction of false memories.....	22
1.3.1 The distinctiveness heuristic.....	24
1.3.1.2 Summary and relevance to the current study .....	27
1.3.2 The impoverished relational-encoding account.....	28
1.3.2.1 Hunt and colleagues' distinction between item-specific and relational information.....	28
1.3.2.2 The activation monitoring framework.....	30
1.3.2.3. Fuzzy-trace theory .....	30
1.3.2.4 Support for the impoverished relational-encoding account .....	31
1.3.2.5 Summary and relevance to the present study .....	32
1.4 Exploring whether distinctive information reduces false memories in children ...	33
1.4.1 Children's susceptibility to the DRM paradigm.....	33
1.4.2 Rationale for the age group selected .....	36
1.5 Research Design .....	36
1.6 Hypotheses .....	39
2.0 METHOD .....	42
2.1 Participants.....	42
2.2 Apparatus and materials.....	42
2.3 Procedure.....	44
3.0 RESULTS .....	46
3.1 Group formation.....	46
3.2 Reporting of critical lure words.....	46
3.3 Recall rates of studied Items that were presented in word lists.....	47

3.4 Critical lure recall rates .....	49
3.4.1 Specific recall .....	51
3.5 Post-recall recognition rates .....	52
 4.0 DISCUSSION .....	<b>555</b>
4.1 The false memory effect in children .....	55
4.2 The effect of studying distinctive information .....	58
4.3 Manipulation of retrieval instructions.....	61
4.4 Differences in reducing false memories between children and adults .....	62
4.4.1 Comparisons with adults (Hege & Dodson, 2004).....	65
4.5 Limitations of this study .....	67
4.6 Conclusions and implications.....	68
 REFERENCES .....	<b>71</b>
 APPENDIX 1.....	<b>77</b>
APPENDIX 2.....	78
APPENDIX 3.....	88
APPENDIX 4.....	98
APPENDIX 5.....	99
APPENDIX 6.....	101
APPENDIX 7.....	110
APPENDIX 8.....	111
APPENDIX 9.....	112

## LIST OF TABLES

<b>Table 1</b> Critical lure error rates in the six instruction conditions	47
--	----

## LIST OF FIGURES

FIGURE 1. Probability of recalling studied items under standard, inclusion, and specific instruction conditions collapsed across picture- and word-encoding conditions. Vertical bars indicate the standard error of the mean. 48

FIGURE 2. Probability of recalling critical lures under standard, inclusion, and specific instruction conditions collapsed across picture- and word-encoding conditions. Vertical bars indicate the standard error of the mean. 50

FIGURE 3. Post-recall recognition rates of both the true recognition rates of studied items and false recognition rates of critical lures and non-critical intrusions collapsed across picture- and word-encoding conditions. Vertical bars indicate the standard error of the mean. 53

## **Abstract**

Furthering our understanding of children's memory mechanisms will expand our knowledge of ways to reduce false memory errors. Hege and Dodson (2004) found that adult participants who studied pictures later recalled items more accurately than participants who studied words. This demonstrated that encoding information in a distinctive manner can reduce false memories. The main aim of the present study was to explore whether using distinctive information within the Deese-Roediger-McDermott paradigm can reduce false memories in children (Deese, 1959; Roediger & McDermott, 1995). Two hundred and forty-three eleven-year-old children (mean age 11.5) studied pictures and words on a screen, each with an accompanying aural label. In contrast to the findings of Hege and Dodson, studying pictures did not reduce false memories in these participants. There were no significant encoding differences between children who studied pictures and children who studied words, as measured by the rate of falsely recalled non-presented critical lure words. Moreover, the children's average rate of recall of the false memories was very low (19.6%). This is just over half the rate reported by Hege and Dodson with adult subjects. On the other hand, manipulation of the test instructions at retrieval had a significant effect on the rate of recall of critical lures. Each group of participants received different retrieval instructions. As expected, the highest numbers of recalled critical lures occurred when subjects were asked to report studied items as well as related items (inclusion recall instructions). This study demonstrated the complex role of encoding and retrieval mechanisms in older children's memory processes, and showed that children do not appear to reduce false memories in a manner that is consistent with adults. The results are discussed in terms of children's processing of pictures and words, eleven-year-olds' semantic development, and links to fuzzy-trace theory.

## 1.0 INTRODUCTION

Researchers have explored how encoding and retrieval manipulations can reduce the level of false memories generated by adults. False memories arise when people remember events that never happened or remember them differently from the way that they occurred (Roediger & McDermott, 1995). As false memories can have serious implications in practice (e.g., sexual abuse claims have later been proved false, and innocent people have been convicted of crimes they did not commit), it is vital to further our understanding of memory mechanisms and the processes which can lead to the reduction of false memories in children.

There has been a recent surge of interest in false memories using word lists after Roediger and McDermott (1995) replicated and extended the work of Deese (1959). This paradigm became known as the Deese-Roediger-McDermott paradigm (or DRM) whereby a critical non-presented lure word is associated with a group of words presented at study. Research has shown that these critical lure words are falsely recalled and recognised at high levels (for a review see Roediger, Watson, McDermott, & Gallo, 2001). In the present study, remembrance of a critical non-presented lure word equates to a false memory effect. By varying the presentation of words with other kinds of information such as pictures, researchers have shown how these encoding manipulations can reduce false memories within the DRM paradigm (e.g., Israel & Schacter, 1997). For example, Hege and Dodson (2004) found that studying pictures compared to words reduced false memories in adults, demonstrating the effect of an encoding manipulation. They found that critical lures were less likely to be reported after picture encoding than after word encoding, which they interpret as supporting a particular encoding account (known as the impoverished relational-encoding account) and a particular retrieval account (known as the distinctiveness heuristic account). These two accounts explain why studying distinctive information reduces false memories in adults.



According to the impoverished relational-encoding account, distinctive information is thought to interfere with the processing of relational information during the initial encoding of study items, leading to reduced false memories. In contrast, the distinctiveness heuristic account explains how false memories can be reduced as a result of the use of a specific retrieval strategy. If people fail to remember distinctive information which they feel they ought to remember, such absence of memory is taken as evidence that the event never occurred. The distinctiveness heuristic reduces false memories by using 'failing to remember' signals to indicate that the test item is new (Dodson, Koutstaal, & Schacter, 2000). Words do not share access to such distinctive information, which leads participants to judge word items as 'old' and produce more false memory errors. To date, most studies in this area have focused on how adults can reduce false memories following the presentation of distinctive information within the DRM paradigm (e.g., Israel & Schacter, 1997; Dodson & Schacter, 2001). In contrast, the current study will explore whether distinctive information reduces false memories in children in line with the encoding and retrieval accounts described above.

Older children have demonstrated differences in false memory recall rates in comparison to adults and younger children. For example, in Brainerd, Reyna, and Forrest's (2002) study with word lists, the researchers found that eleven-year-olds' false recall rates were higher than those of 5- and 7-year-old children but still only half the level of adults' rates. The current study focuses on eleven-year-old children (mean age 11.5 years) to examine this difference in older children's susceptibility to false memory errors, and further our understanding of their memory processes in the study of distinctive information. By this age, children are thought to have completed their developmental shift from phonological to semantic processing (Dewhurst & Robinson, 2004).

The main aim of the present study was to explore whether using distinctive information can reduce false memories in children. Half of the participants studied pictures while the other half studied words. Both the pictures and words used originated from the word lists in the DRM paradigm. The retrieval instructions were manipulated to explore whether children would reduce false memories in line with the impoverished relational-encoding account and the distinctiveness heuristic account. In this manner, the study explored whether children would demonstrate reduced false memories in a way that was consistent with adults, as reported by Hege and Dodson (2004).

In addition to testing the encoding effect of varying pictures and words, the current study also explored the effect of retrieval manipulations on children's abilities to reduce false memories within the DRM paradigm. In particular, 'inclusion' recall instructions were implemented in order to explore whether critical lures were reported less often after picture encoding than after word encoding. Inclusion recall instructions involved subjects reporting as many studied items as they could plus any related items. After they had completed their recall task they were then instructed to go through their reported items and place a tick next to those that were actually presented during study. According to the impoverished relational-encoding account, critical lures are less likely to come to mind after picture encoding than after word encoding for participants given inclusion recall instructions. In order to explore whether the children in the study would use the distinctiveness heuristic as a retrieval strategy, 'standard recall' instructions and 'specific recall' instructions were implemented in addition to inclusion recall instructions. Participants given standard recall instructions were to recall as many study items as they could remember. Those given specific instructions were asked to recall only study items that they could specifically remember being presented on the projector screen. The distinctiveness heuristic account predicts a larger difference between encoding conditions

under standard recall instructions than under inclusion recall instructions. Hege and Dodson (2004) only found support for the distinctiveness heuristic in their post-recall recognition test, where participants in the inclusion recall instruction condition went through their words and placed a tick next to words they remembered seeing at study. In order to explore whether the distinctiveness heuristic might be applied at recall, the current study created an additional instruction condition, where participants were asked to write down only the specific stimuli that they saw on the projector screen (specific instructions).

Before addressing all of these specific issues, however, the first section provides a more general overview of the literature relating to false memories and the DRM paradigm. The second section describes the rapidly evolving literature on how false memories can be reduced. The third section examines how distinctive information can reduce false memories, including a closer examination of the impoverished relational-encoding account and the distinctiveness heuristic account to explain why distinctive information reduces false memories in adults. The final section examines research involving children's potential to reduce false memories in terms of 1) their susceptibility, 2) the age group selected, and 3) the influence of distinctive information.

### ***1.1 False Memories and the DRM paradigm***

Memory is prone to error due to its reconstructive nature. It is influenced by the way people retrieve memory in pieces over time rather than as a whole entity (Hyman & Pentland, 1996; Braun-LaTour, LaTour, Pickrell, & Loftus, 2004). Baddeley (2001) notes that memory involves encoding, storing, and retrieving information. People can create memories using the information from memory in combination with other related knowledge, rather than retrieving a memory as a whole entity (Hyman & Pentland, 1996). According to Bartlett (1932),

memory gives meaning to our experiences, shaped by previous experience and what we learned from it (Bartlett, 1932; Braun-LaTour et al., 2004). Bartlett also notes that memory is vulnerable to human error, mixing fact with interpretation until they are indistinguishable. The reconstructive nature of memory can lead people to claim to remember false memories.

### ***1.1.1 Defining False Memories***

Memories can be changed or created by our imaginations, by leading questions, and by other people's recollections of the same events. The false memory phenomenon has been demonstrated by observations which show how a true event was remembered but in a mistaken way (for review see Loftus, 1997). For example, the memory of a story was distorted after multiple retellings, and remembered word lists could include words that were not studied, but which were related to the words on the list.

False memories can be defined as "either remembering events that never happened, or remembering them quite differently from the way they happened" (Roediger & McDermott, 1995, p.803). They can occur when people believe they have experienced an event, although in fact they have not (Dodson et al., 2000). The way information is presented to us and how our decision-making processes interpret it can affect how accurately we attribute the source of our memories. This can make us more prone to making memory errors (Payne, Neuschatz, Lampinen, & Lynn, 1997). Roediger defines such errors as "cases in which a rememberer's report of a past event seriously deviates from the event's actual occurrence" (Roediger, 1996, p.76). Memory distortions are of concern, as they can cause us to question the reliability and accuracy of our past memories (Dodson, Koutstaal, & Schacter, 2000).

### ***1.1.2 Suggestibility of memory errors: eyewitness memory research***

Further evidence that memory is reconstructive comes from eyewitness memory research. Studies have shown that if people are given misleading post-event information they are likely to include this misleading information into their memory of the original event (for review see Loftus, 2003). For example, Loftus and Palmer (1974) demonstrated how subjects' responses and perceptions of an event can be influenced by leading questions. After viewing films of an automobile accident, subjects were asked questions such as: "About how fast were the cars going when they *smashed* into each other?" This type of question demonstrated higher estimates of speed than questions in which the word *smashed* was replaced with *collided*, *bumped*, *contacted* or *hit*. Further, the subjects who had received the earlier question with the verb *smashed* were later more likely to answer that they had seen broken glass, even though there was no broken glass shown in the original event. Loftus and Palmer's research demonstrates what they deemed the 'misinformation effect': how people's recollections can become distorted after viewing an event, and then receiving subsequent misleading information about that event (Loftus, 1997). As misleading information has been shown to influence participants' memory of original events, it follows that people can recall false or inaccurate memories.

### ***1.1.3 The false memory phenomenon***

There is ample evidence of the false memory phenomenon. Even George W. Bush, the President of the United States, has succumbed to the false memory effect. On several occasions when asked to describe how he heard the news of the 9/11 terrorist attacks, his answers contained significant inconsistencies (Greenberg, 2004). This demonstrates how inaccurate our memories can be and how susceptible they are to external influences.

Researchers have planted false memories as a way of showing the strength of the false memory phenomenon.

People have been led to believe that entire childhood events have happened to them, such as being lost in a shopping mall, even though these events never occurred (e.g., Loftus & Pickrell, 1995). This can be achieved through collaboration with family members in order to combine actual memories with suggestions from others (Loftus, 1997). Studies such as these demonstrate the powerful effect of planting false memories. People can succumb to the false memory effect and become convinced that false occurrences were real.

#### ***1.1.4 Impossible Memories***

Even stronger evidence for the false memory phenomenon comes from the implantation of impossible memories. Braun-LaTour and colleagues demonstrated an impossible memory by manipulating an advertisement for Disneyland. Many participants ‘remembered’ seeing Bugs Bunny as part of their experience at Disneyland (e.g., Braun-LaTour et al., 2004; Braun, Ellis, & Loftus, 2002). This demonstrated the effect of advertising received after an experience, on the way an experience is remembered (Braun, 1999; Braun-LaTour et al., 2004). The memory which participants described is impossible: Bugs Bunny is a Warner Brothers character and would not be found at Disneyland.

#### ***1.1.5 The DRM paradigm***

Word lists were used in the present study to demonstrate a false memory effect. As background, a seminal study by Deese (1959) provided evidence for false memories, when he demonstrated that false recall can occur following the presentation of word lists. Roediger and McDermott (1995) replicated Deese’s (1959) study, using the lists that Deese had found

evoked the most false recall. This extension of Deese's research and the ability of the design to demonstrate false memory errors became recognised as the Deese-Roediger-McDermott paradigm (DRM). Roediger and McDermott (1995) presented subjects with several lists of words constructed so that all the words in each list were associated with a critical (non-presented) word. For example, for the critical word *sweet* the list words were *sour, candy, sugar, bitter, good, taste, tooth, nice, honey, soda, chocolate, heart, cake, tart* and *pie*. After the subjects had studied the word lists, they were asked to recall the words and often mistakenly recalled the non-presented lure words, such as *sweet*.

Because the present study is directly related to the DRM paradigm, some additional pertinent details regarding the two experiments conducted by Roediger and McDermott (1995) are given here. In their first experiment the subjects heard and recalled the lists and then completed a recognition test on both studied and non-studied items. Roediger and McDermott's research showed that the critical non-presented items such as *sweet* were recalled at about the same level as items actually presented in the middle of the lists.

Their second experiment demonstrated the strength of false memories. Roediger and McDermott (1995) found that false recognition responses were frequently made with high confidence or were frequently accompanied by 'remember' judgments whereby the subject claimed to be able to mentally 'relive' the experience. These responses may have occurred because the lists contained words that were associated with the critical non-presented words or words of similar concepts, and although the critical words were not presented, they were the prototypes from which each list was generated. Therefore the lists encouraged schematic processing.

Roediger and McDermott's experiments highlighted the role of retrieval processes in false recall and false recognition. False remembering may arise from repeated attempts at retrieval. Subjects in the experiment usually recalled the critical word toward the end of the set of their list of recalled items, which suggests that prior recall of related items may trigger false recall.

Roediger and McDermott (1995) found that subjects frequently recalled or recognized the critical non-presented items (such as *sweet*) as having come from the study lists. The DRM paradigm elicits high levels of false recall and demonstrates the strength of such false memories (Hege & Dodson, 2004).

### ***1.1.6 Summary***

The false memory phenomenon, and the DRM paradigm in particular, demonstrate how people can remember words that have never been presented to them. It appears that people remember semantically associated words that do not appear to be consciously registered (Riegler, 2005). This demonstrates the reconstructive nature of memory, and shows that it can be retrieved in fragments and combined with additional related knowledge rather than stored as a whole entity. Difficulties in distinguishing between real and possible events have important wider practical implications, such as the recovery of memories of child sexual abuse. It is therefore essential that we look for ways to reduce the occurrence of false memories.

### ***1.2 Reducing False memories***

According to Dodson, Koutstaal, and Schacter (2000), there are two important ways to reduce or avoid memory misattributions, involving encoding influences and retrieval influences.



The first method involves enhancing the encoding and subsequent recollection of source-specific information. In the DRM word list paradigm, if individuals are allowed to repeatedly study and recall the related presented words, then false memory errors can be reduced. This is purportedly due to the greater exposure to the studied words, which provides more opportunities to encode the specific features of the individual words on the lists. A decline in the false recognition rates could be due to improved memory for the studied words. False memories are also reduced when participants encode and later recollect detailed item-specific information. Thus within this method, both encoding specific item information and encoding information through multiple study test trials can reduce false recognition responses to lure items (Dodson et al., 2000).

Another way of reducing false memories is through retrieval influences. Factors such as methods of prompting memory can influence the type and amount of information that people remember. Changing the format of the memory query appears to affect whether participants will make false recognition errors. For example, when people receive ‘old’ and ‘new’ instructions (where ‘old’ encompasses a picture that was seen during the study phase, while ‘new’ refers to a picture that was not seen earlier), they are biased to respond on the basis of overall familiarity. A retrieval orientation that promotes a response on the basis of specific item information could be a way to reject false memories. Performance can improve when the test response requirements encourage participants to examine memory for source information (Dodson et al., 2000).

Dodson et al. state that the effectiveness of the type of retrieval orientation for reducing false recognition responses depends on two variables: how individuals evaluate their memories and the similarity of the memories to one another. False memories can be reduced when

individuals are oriented at retrieval to scrutinize their memory for specific source information or other item-specific details (Dodson et al., 2000).

### ***1.2.1. Encoding processes in the reduction of false memories***

Read (1996) noted that the magnitude of the false memory effect has been enhanced or diminished by employing certain encoding instructions. For example, when rehearsal activities are elaborate and encourage subjects to consider the meaning of the study stimuli (e.g., Craik & Lockhart, 1972), participants may be more likely to elicit a critical lure word.

On the other hand, encoding processes can also decrease the availability or likelihood of a critical lure or false memory coming to mind at retrieval. For example, Hege and Dodson (2004) found evidence for reduced false memories in their participants after studying pictures, compared to studying words, which they explain in terms of reduced impoverished encoding of relational or associative information. From this perspective, studying pictures is thought to interfere with the encoding of relational information. Fuzzy-trace theory and spreading activation theory, explored later in this introduction, can also account for this effect. For now, what is clear is that the way that information is presented at study can have a significant effect on memory for an event. Also, research has demonstrated that encoding distinctive information in the form of pictures compared to words can dramatically reduce the recall of false memory errors in adults. This concept of distinctiveness will be described in more detail subsequently. The current study manipulates the encoding conditions (pictures vs words) in order to explore whether participants studying information as pictures will make fewer errors than participants studying words.

### ***1.2.2. Retrieval suppression mechanisms in the reduction of false memories***

Retrieval processes can be effective in reducing false memories. When an individual attempts to remember information about an event, he or she may adopt some kind of inferential strategy. One such strategy is the distinctiveness heuristic, whereby absence of memory for distinctive information indicates that a study item is new (Dodson et al., 2000). This distinctiveness heuristic may be applied when an individual fails to remember information about a past event that he or she is expected to remember. That is, this retrieval strategy depends on an individual's metamemorial beliefs about expected information. It has been demonstrated to reduce false memories when individuals reason that if they fail to remember expected information then it cannot have occurred (e.g., Dodson & Schacter, 2001). Participants who study distinctive pictorial information, for instance, are thought to have detailed recollections about the studied items, unlike participants who study words. Moreover, those who have encoded pictures are thought to take the absence of memory for this type of information of a given picture as an indicator that a test item is new.

Hege and Dodson (2004) note that there are several other similar metacognitive retrieval strategies whereby people's behaviour is guided by the absence of memory for expected information (e.g., Brewer & Treyens, 1981; Brown, Buchanan, & Cabeza, 2000; Brown, Lewis, & Monk, 1977). One that is similar to the distinctiveness heuristic is a 'lack of knowledge inference' (Collins, Warnock, Aiello, & Miller, 1975; Gentner & Collins, 1981). Gentner and Collins (1981) describe this situation as a 'metainference' for ruling out events based on the lack of expected knowledge for events. In this inference, failure to find information in memory leads to the conclusion that the assertion is false.

Some retrieval strategies relate to individuals' metamemorial beliefs about the source of their memories. According to Johnson and colleagues' source-monitoring framework (SMF), the accuracy of memories results from an interaction between activated information and judgment processes (Johnson, Hastroudi, & Lindsay, 1993). When characteristics of memories overlap from different sources it can be more difficult to attribute them to their original source (Mather, Henkel, & Johnson, 1997). Individuals can adopt decision biases based on their metamemorial beliefs relating to the memorability of source information. An example is the "I'd know if I did it" retrieval bias effect, where memories of actions are confused with memories of imagined actions. Anderson (1984) demonstrated that subjects were biased toward assuming that actions were more memorable than other activities. This is one of several decision biases concerned with individuals' metamemorial beliefs about the source of information (e.g., Johnson & Raye, 1981; Foley, Johnson, & Raye, 1983).

Another retrieval mechanism that is pertinent to mention is the recall-to-reject retrieval mechanism, whereby false memories are suppressed, based on remembering specific prior events (for a review see Clark & Gronlund, 1996 pp.56-57). From this account, specific memorial information leads participants to correctly reject familiar but incorrect items as a result of remembering specific information about an earlier event (e.g., Brainerd, Wright, Reyna, & Payne, 2002). Ghetti, Goodman, and Qin (2002) interpreted their own experimental findings in terms of recall-to-reject processes: participants who studied words with associated pictures, in comparison to participants who studied solely words, were better able to reject critical lures. This resulted in reduced false memory errors.

In summary, there are two ways that individuals can edit out or suppress false memories at retrieval. The first is by using a retrieval strategy where false memories are ruled out by the

absence of expected memorial information. This occurs in the distinctiveness heuristic account and the lack of knowledge inference. The second way individuals can reduce false memories is by remembering specific memorial information, as, for example, in the recall-to-reject hypothesis.

### ***1.2.3 Overview of encoding and retrieval processes and relevance to the current study***

The processes undertaken at encoding and retrieval can influence whether false memories are evoked. Schacter, Norman, and Koutstaal (1998) provide a review of a constructive memory framework (CMF) outlining the processes that operate at encoding and at retrieval. When the appropriate conditions of encoding and retrieval are not met, inaccurate memories can arise.

CMF stresses the importance for pattern separation at encoding, declaring it is necessary for episodes to be stored in a manner that allows them to be accessed separately at test. At encoding, the features that make up an episode need to be linked together to form a ‘coherent representation’. If this feature binding is not coherent, it can lead to source memory failure, where people retrieve pieces of an episode but cannot recollect how or when the pieces were acquired (Schacter, Norman, & Koutstaal, 1998).

During retrieval, a process of pattern completion occurs, where a subset of the features of the past experience is reactivated. The activation is then thought to spread to the other features of the experience. According to the CMF, retrieval cues need to be very specific so that they activate only single episodes. If this does not occur, then multiple episodes will be activated and accessed at the time of test recall, which can result in source confusions and subsequent false memories (Schacter, Norman, & Koutstaal, 1998).

The CMF demonstrates the importance of the processes that occur at encoding and retrieval. The current study involves encoding items in a distinctive manner in the form of pictures. Picture encoding has the potential to decrease activation to related lure words and so impoverish the encoding of relational information (Hege & Dodson, 2004). As discussed earlier, a number of retrieval processes can contribute to the reduction in false memories. In order to explore the retrieval processes in the current study, a recall test with standard and inclusion instructions was employed, inspired by the work of Hege and Dodson (2004), Jacoby (1991), Brainerd and Reyna (1998b), and Schacter, Cendan, Dodson, and Clifford, (2001). The use of this retrieval manipulation allows examination of the applicability of the impoverished relational-encoding account and the distinctiveness heuristic account to the retrieval processes of children.

### ***1.3 Why distinctive information reduces false memories in adults: two accounts to explain the reduction of false memories***

Distinctive information refers to information that is thought to be encoded in a more memorable manner. Several studies have shown how the presentation of distinctive information can reduce false memories in adults. Hunt and Einstein (1981, p. 498) define distinctiveness as “an inverse function of the number of features in a trace shared by other to-be-remembered events”. When researchers have varied the encoding manipulations in the DRM paradigm so that some participants study items in a more distinctive manner using images, false memories have been reduced (Hege & Dodson, 2004). Israel and Schacter (1997) demonstrated that when items are studied with pictures in addition to words, the number of false recognition errors in the DRM paradigm decreases. Similarly, when words are said aloud at encoding, fewer errors have resulted than when words are heard at the time of encoding while seeing them (Dodson & Schacter, 2001). Hege and Dodson found that

fewer false memory errors occurred after studying information given as pictures as opposed to words. This focus on the distinctive properties of the items is thought to have reduced the probability of recalling false critical lures (Storbeck & Clore, 2005).

It seems clear that pictures are encoded in a more distinctive manner as opposed to words. Hege and Dodson (2004) explored two potential accounts of why false memories are reduced when studying pictures using the DRM paradigm. The impoverished relational-encoding account and the distinctiveness heuristic account give different explanations for the reduction in false memories after the encoding of distinctive information. According to the impoverished relational-encoding account, critical lures evoke less memorial information after picture encoding than after word encoding. In the distinctiveness heuristic account, on the other hand, critical lures are thought to evoke similar amounts of memorial information after picture and word encoding, but picture encoding may allow participants to suppress false recognition of the critical lures at retrieval. This is achieved by means of a retrieval strategy (the distinctiveness heuristic) whereby the absence of memory for expected distinctive information is indicative of an event's non-occurrence. Participants in their study were given inclusion instructions to recall studied and other items that were related to what was presented in picture-encoding and word-encoding conditions, in order to explore these two accounts. The results lent support to the impoverished relational-encoding explanation, whereby critical lures are less likely to come to mind after picture encoding than after word encoding. Hege and Dodson (2004) found support for the distinctiveness heuristic account from their post-recall recognition test. This test measured the proportion of studied items and critical lures, reported under the inclusion instructions. However, the results from the free-recall test failed to support the distinctiveness heuristic account. The following section will further explore

these two accounts which have provided potential explanations for reduced false memories in adult participants.

### ***1.3.1 The distinctiveness heuristic***

False recognition rates can be influenced by the strategies that people use at retrieval to assess or evaluate the remembered information (Dodson et al., 2000). As described above, the distinctiveness heuristic is a retrieval strategy which depends on the joint influences of the encoding and retrieval stages of memory. The absence of memory for expected information is taken as evidence that an event is new. Studying the same items with accompanying pictures instead of words alone dramatically reduces false recognition rates in adults (Israel & Schacter, 1997). According to the distinctiveness heuristic account, this finding is due to different recollective expectations from studying pictures versus words. Budson et al. (2005) suggest that use of the distinctiveness heuristic involves recollection which differentiates between item types. Pictorial information can be retrieved in this way, but additional retrieval processes are needed to distinguish between item types in verbal information.

Israel and Schacter (1997) were the first to demonstrate the workings of the distinctiveness heuristic. According to this account, individuals' metamemorial beliefs will affect the types of memories they feel that they ought to remember. In their experiment, Israel and Schacter (1997) found a dramatic reduction in false recognition errors when semantic associates were accompanied with pictures, as opposed to conditions when solely words were studied. This effect was thought to occur because adult participants studying pictures rejected new words as "they lacked the distinctiveness qualities associated with remembered pictures" (Schacter, Israel, & Racine, 1999, p. 2). Israel and Schacter (1997) explained that studying pictures is thought to result in more distinctive recollections than studying words. These distinctive



perceptual representations require a specific recollection of a test item before it is classed as old (Israel & Schacter, 1997), leading to more accurate memory for pictorial stimuli.

Individuals feel that they ought to remember distinctive pictorial information and information that they have said aloud. Individuals access either the pictorial information or the spoken information, and use it as a basis for judging items that have been studied, igniting a distinctiveness heuristic (Dodson et al., 2000). If people do not remember distinctive information they consider it an indicator that the information is new. Detailed recollections are not thought to occur in participants in the word-encoding conditions, where decisions are not made on the presence or absence of memory for distinctive information (Dodson et al., 2000).

Further evidence for reduced false recognition errors after pictorial encoding was provided by Dodson and Schacter (2002). After participants studied pictures, words, or a mixture of both they undertook a recognition test, which involved studied items that appeared once and new items that appeared twice. The researchers found that participants who studied items as pictures compared to words or a mixture of both made fewer false recognition errors. This was despite the fact that new words were shown to them two or more different times, whereas the studied items were only shown once in the recognition test. Results indicated that participants in the word-encoding condition were susceptible to falsely recognising repeated new words. In contrast, studying pictures produced a reduction in false recognition rates to the repeated new words (Dodson & Schacter, 2002).

Dodson and Schacter (2002) also explored the influence of diagnosticity and metacognitive control, and their impact on participants' use of the distinctiveness heuristic. Diagnosticity

was investigated by varying the number of study items which appeared as pictures. The researchers found a suppression effect, as false recognition was suppressed after pictorial encoding as described above. Dodson and Schacter (2002) concluded that participants were less likely to falsely recognize repeated new words when they studied items, as a result of evoking a distinctiveness heuristic.

The authors also sought to determine at what level participants would abandon the distinctiveness heuristic, and explored how many items need to be distinctive before the strategy is invoked (Dodson & Schacter, 2002). Therefore, some participants were shown pictures for 25% of the items while others saw items as pictures for only 10% of the study time. The results suggested that participants require about 25% of distinctive study information for the distinctiveness heuristic to ignite. In order to assess the distinctiveness heuristic as a metacognitive mechanism, the expectations of the participants were manipulated. That is, some participants thought that the test would contain items that were studied as pictures (uninformed), while others did not (informed). Those in the uninformed distinctive group received standard test instructions whereby they were told they would be tested on all of the study items. Those in the informed distinctive group were told that they would not be asked about picture study items, and that the test included only word study items. The results demonstrated that participants did not use a distinctiveness heuristic when they believed that they would not be tested on the picture study items. The data further indicated that “the distinctiveness heuristic is a strategic mechanism that participants can turn on or off depending on their expectations of whether they will or will not be tested on the picture study items” (Dodson & Schacter, 2002, pp. 794-795). This study demonstrated how the distinctiveness heuristic is a tool for reducing false memories.

More important for the present study is the finding that age plays a role in the application of a distinctiveness heuristic. Schacter, Israel, and Racine (1999) found age was a factor in decision processes and the use of a distinctiveness heuristic. In their experiment, older adults showed an increased susceptibility to false memory errors with higher false recognition levels compared to younger adults. However, both older and younger adults demonstrated the use of a distinctiveness heuristic.

This retrieval strategy has been demonstrated with other distinctive stimuli. Dodson and Schacter (2001) explored participants' use of a distinctiveness heuristic to reduce false memory in an experiment where participants studied lists of semantically related words and either said or heard words at study. In Dodson and Schacter's first experiment, they found that those participants who were instructed to say words aloud when they saw them at study (the 'say' encoding condition) yielded fewer false recognition responses to related lure items than those participants who only heard someone else say the words they saw at study (the 'hear' encoding condition). This suggests that participants used a distinctiveness heuristic, which reduced the rate of false recognition judgments. In addition, the distinctiveness heuristic was applied when participants heard some words at study and said others at study (Experiment 2). Participants are thought to expect to remember words that they would have said. If this expected information is absent, then the participant is likely to infer that the test word is new (Dodson & Schacter, 2001).

### ***1.3.1.2 Summary and relevance to the current study***

The distinctiveness heuristic is a retrieval strategy which can aid effective suppression of false memories. According to this view, individuals base their retrieval decisions on expected metamemorial beliefs about the type of information they feel they should remember. Several

studies have demonstrated adults' use of this heuristic as a retrieval tool. It has been suggested that children may not have developed the metacognitive thinking that would aid in their decision making (Dodson et al., 2000). Ghetti, Goodman, and Qin, (2002) have demonstrated that five- and seven-year-old children do not show the workings of the distinctiveness heuristic. The current study will explore whether eleven-year-old children employ such a mechanism.

### ***1.3.2 The impoverished relational-encoding account***

According to the impoverished relational-encoding account, studying pictures (distinctive information) interferes with the encoding of relational information, which results in fewer false memory errors. This account draws together several different theoretical approaches which are explored below. It is a compilation of Hunt and colleagues' distinction between item-specific and relational information, the activation-monitoring framework, and fuzzy-trace theory. These explanations share the premise that studying distinctive information decreases the amount of memorial information that is elicited by the related-lure item (Hege & Dodson, 2004) in the DRM paradigm. It is not known whether eleven-year-old children will demonstrate patterns of behaviour consistent with the impoverished relational-encoding account, as has been shown with adults. The following section provides a detailed description of the three theoretical accounts that comprise the impoverished relational-encoding account.

#### ***1.3.2.1 Hunt and colleagues' distinction between item-specific and relational information***

Work by Hunt and colleagues has revealed a distinction between item-specific and relational information (Hunt & Einstein, 1981; Hunt & McDaniel, 1993). In item-specific processing, the features and distinctive qualities of items are encoded (Storbeck & Clore, 2005). Relational information refers to words that are conceptually related to a studied item. This

type of processing involves encoding items in relation to other concepts in memory (Storbeck & Clore, 2005). Einstein and Hunt's (1980) research showed the importance of relational information and item-specific information to memory. Item-specific and relational processing can affect learning and remembering in both favourable and unfavourable ways. Hege and Dodson (2004, p. 787) note how "studying distinctive information may increase memory for item-specific information at the expense of memory for relational information".

Using the DRM paradigm, Smith and Hunt (1998) found a modality effect on false memory. Their studies demonstrated a reduction in the level of false memory after visual presentation, compared to aural presentation. According to Smith and Hunt, the cues of free recall instructions can re-establish the critical items as the presented items (Smith & Hunt, 1998). The reduction in false memory is thought to be attributed to item-specific processing, which can facilitate the discriminative process of distinctiveness at retrieval (Smith & Hunt, 1998). According to Smith and Hunt (1998, p. 714), this modality effect "suggests that even subtle differences in processing of critical and presented items at study can service the distinctive processing in retrieval that is necessary to reduce false memory". Smith and Hunt (1998) further believe that the level of false memory can be reduced through item-specific processing of list words, which can facilitate discrimination of the items from non-presented items. They postulate that differential processing during encoding can facilitate discrimination at retrieval, which produces a reduced false memory effect (Smith & Hunt, 1998). Hunt and colleagues' work demonstrates how item-specific information decreases the amount of memorial information elicited by the related lure item, leading to reduced false memory errors.

### ***1.3.2.2 The activation monitoring framework***

Roediger and colleagues presented another theoretical approach known as the activation-monitoring framework. From this perspective, reduced false memories could occur because the study of distinctive information decreases the spread of activation from studied items to the related lure (Hege & Dodson, 2004). Spreading activation is likely to occur at encoding and during retrieval in the DRM paradigm (Roediger, Balota, & Watson, 2001). According to the activation-monitoring framework, concepts are activated in episodic or semantic memory and are thought to spread among neighbouring concepts. Thus the mental representation of activated words can partially activate related words in an associative semantic network. In this way, words can arouse an implicit associative response. Roediger and colleagues' framework explores the influence of activation processes and interconnected and related networks in the development of false memories (Roediger, Balota, & Watson, 2001). Thematically related items in word lists can activate and prime critical non-presented items. Encoding information as pictures as opposed to words can decrease activation of the critical lure (e.g., Roediger, Balota, & Watson, 2001; Roediger, Watson, McDermott, & Gallo, 2001; Hege & Dodson, 2004).

### ***1.3.2.3. Fuzzy-trace theory***

A final important theoretical position to consider is the fuzzy-trace theory. According to fuzzy-trace theory, there are two types of memory traces that result from experience: gist traces and verbatim traces (Brainerd & Reyna, 1996, 1998a). The former refers to the general meaning of experience, while the latter represents specific attributes (Roediger et al., 2001). Brainerd and Reyna state that the main difference between the two types of information is that verbatim memory is located in the part of memory that records the subject's actual experiences. In contrast, gist traces are added to memory by the individual rememberers.

Brainerd and Reyna distinguish between the two traces, viewing verbatim traces as records of ‘actual’ experiences and gist traces as ‘understanding’ of their experiences (e.g., Brainerd & Reyna, 2004). From this perspective, correct recall and recognition results from information extracted from verbatim traces, while false recall and recollection is thought to result from the extraction of gist information. Brainerd and Reyna’s 1998 experiment demonstrated the effect of memory tests that encourage reliance on gist information. The authors found that recognition memory tests which encouraged reliance on gist information can lead participants to accept things that were not experienced more easily than things that were experienced. Fuzzy-trace theory provides a theoretical account which explains how the study of distinctive information may decrease the occurrence of, or reliance on, gist representations, which in turn should lead to fewer errors (Brainerd & Reyna, 1998a).

#### ***1.3.2.4 Support for the impoverished relational-encoding account***

Arndt and Reder (2003) present evidence in support of the impoverished relational-encoding account as an explanation for reduced false recognition of critical lures. They presented study items in unusual fonts and explored what effect these distinctive fonts would have on true and false recognition. Participants falsely recognized fewer critical lures from items that were presented using distinctive fonts. The unusual fonts placed emphasis on the encoding of item-specific information. This, in turn, diminished the encoding of relational information, and lent support to the impoverished relational-encoding account. Arndt and Reder’s results are not consistent with the distinctiveness heuristic account, which would predict a reduction in false recognition rates to all critical lures, and not just those that were presented in unique fonts. Arndt and Reder found that false recognition varied across the font conditions in all three of their experiments, even when the experiment was manipulated within participants. This would suggest the use of memory-based processes. In contrast, the distinctiveness heuristic uses

decision-based processes. Besides, the distinctiveness heuristic is not likely to demonstrate false recognition errors across conditions in a within participants design (Schacter et al., 1999; Dodson & Schacter, 2001).

#### ***1.3.2.5 Summary and relevance to the present study***

In summary, Hunt et al.'s distinction between item-specific and relational information, the activation-monitoring framework, and fuzzy-trace theory all combine to form the impoverished relational-encoding framework. According to this account, distinctive information restricts relational and associative information. Distinctive information possesses less of the memorial information that is elicited by a related-lure item (Hege & Dodson, 2004). In support of this, Hege and Dodson found that item-specific encoding can impoverish relational processing. In turn, participants made fewer errors after studying item-specific information in the form of pictures relative to words. Hege and Dodson's finding indicates that picture encoding interfered with relational information and led to reduced false memory errors.

The current study explored whether studying pictures suppresses the encoding of relational information in eleven-year-old children. This was measured by the reporting of critical lures by participants when they were instructed to report studied items as well as related items. If participants in this inclusion condition (inclusion instruction condition) reported critical lures less often after picture encoding than after word encoding, then the results would lend support to the impoverished relational-encoding account.



#### ***1.4 Exploring whether distinctive information reduces false memories in children***

To my knowledge only one study has explored whether distinctive information reduces false memories in children. Ghetti, Goodman, and Qin (2002) found that distinctive information reduced false memories in children aged 5 and 7. Children made fewer errors after studying distinctive information. Moreover, when words were encoded with pictures, children were more likely to recognise studied words. The study also examined the role of the distinctiveness heuristic to account for the reduced errors. Ghetti et al. consider it unlikely that the five- and seven-year-old children in their study implemented the distinctiveness heuristic, on account of the explicit and systematic nature of the heuristic. Notwithstanding this finding, Ghetti et al.'s results demonstrate that distinctiveness can reduce false memories in children.

It is vital that we further our understanding of the potential developmental differences in children that can affect false recall and recognition. This research seeks to explore whether the use of distinctive information reduces false memories in eleven-year-old children, an area that needs further investigation. It also aims to examine whether older children will show reduced false memories by using the retrieval strategy of the distinctiveness heuristic. One of the main conclusions by Ghetti et al. was that future research is needed to explore whether there is a developmental change in the use of item-distinctive information (Ghetti et al., 2002). The present study initiates research in an area where literature is lacking. It concerns the exploration of the mechanisms or processes that might be involved in the reduction of false memories in older children.

##### ***1.4.1 Children's susceptibility to the DRM paradigm***

There is conflicting evidence in the literature about children's susceptibility to false recognition in the DRM paradigm. Roediger and McDermott (1995) believe that young

children would be particularly prone to the DRM effect, due to their deficient source-monitoring skills (Foley, Johnson, & Raye, 1983). On the other hand, fuzzy-trace theory suggests that young children will not show susceptibility to the DRM effect, as they are less likely to create gist memories of the semantic relatedness of the DRM lists (Dewhurst & Robinson, 2004).

In support of the fuzzy-trace account, Brainerd, Reyna, and Forrest (2002) discovered that the false memory phenomenon is less pronounced in early childhood. Lists from the DRM task were presented aurally and the participants were given a form of recall test. In the 5-7 year age group the critical lure false recall level was very low, with rates of 6-7% in their first two experiments and 10% in their third experiment. In the 11-year-old children, the critical lure false recall rate was higher than for the 5-7 year age group, but still less than half of that of the adult percentage (27% and 64% respectively).

Previous studies with this age group have suggested that children are using a range of semantic-processing strategies spontaneously. These strategies include elaboration and organisation, and are thought to aid in extracting the gist of individual words and in connecting gist across multiple words (Brainerd, Reyna, & Forrest, 2002; Bjorklund, 2000; Bjorklund & Muir, 1988). This suggests that there are marked developmental differences between the two age groups (5-7 year olds and eleven-year-olds) in the processes which are important to the DRM illusion. Brainerd, Reyna, and Forrest, (2002) explain this developmental difference in terms of fuzzy-trace theory. They believe that “verbatim and gist memories operate independently and develop differently from young childhood to adulthood” (Diliberto-Macaluso, 2005, p. 14; Brainerd et al., 2002). Verbatim memory is thought to improve from young childhood to early adolescence, but gist memory is not thought to be as

pronounced in younger children. According to Brainerd and Reyna (2004), young children may not be able to extract the meaning or gist of DRM lists, which could explain why they demonstrate a low rate of false memory errors. This absence of gist memory is thought to explain why the false memory levels were so low in young children and increased through to young adolescents (Brainerd, Reyna, & Forrest, 2002; Diliberto-Macaluso, 2005). Further, Brainerd et al. explain how the ability to spontaneously connect gist takes a long time to develop. The researchers found a difference between the levels of false memories in older children and in adults. It is thought that the lower levels of false recall in older children, compared to adults, demonstrate that the development of the ability to connect the gist of individual words continues to increase until adulthood. In support of this view, Diliberto-Macaluso (2005) found a false memory effect in young adolescents (ranging in age from 9.5 to 12 years) that was comparable to Brainerd et al.'s findings with eleven-year-old children. Both studies demonstrate that the level of false memory in older children is lower than that of adults.

In contrast, Ghetti, Goodman, and Qin (2002) did not find any significant age differences in the false memory effect in their study with five- and seven-year-old children. In addition, they found no marked differences in false memory formation relative to adults, with children producing comparable false memory effects in recall and recognition for critical lures. According to Brainerd et al., these inconsistencies in the findings may be due to the different experimental procedures, with differences in the length of the DRM lists (Ghetti et al.'s word lists were 7 words, not 15) and differences in the presentation of the stimuli. They suggest an explanation from fuzzy-trace theory, whereby the presentation of shorter lists and visual stimuli could have resulted in a reversal of the developmental trend of the false memory effect for two reasons. Firstly, these variables have shifted performance on the memory test to

reliance on verbatim memory. Secondly, it is thought that the size of this shift may increase with age (Brainerd, Reyna, & Forrest, 2002).

#### ***1.4.2 Rationale for the age group selected***

Thus far, the role of distinctive information in reducing false memories has solely been explored in adults and in 5- and 7-year-old children. Brainerd et al. (2002) demonstrated marked developmental differences in false recall and recognition between younger and older children, and between older children and adults, using DRM word lists. Older children had a higher occurrence of false memories than younger children, but their levels of false recall were still lower than adult levels. Diliberto-Macaluso (2005) also found lower levels of false recall with word lists in older children relative to adults, which indicates that this age group is of particular relevance to the study of false memories in the DRM paradigm. It is also useful to examine the role of distinctive information in reducing false memories in older children. By the age of eleven, children are thought to have completed their developmental shift from phonological to semantic processing (see Dewhurst & Robinson, 2004). Therefore, by this age, it is thought that children can relate the DRM lists semantically. Whether distinctive stimuli can demonstrate reductions in false memories with older children is an open empirical question.

#### ***1.5 Research Design***

The aim of this research is to explore whether distinctive information will reduce false memories in 11-year-old children, and if so, whether this can be explained by two accounts which have reliably explained false memories in adults. There are two potentially important differences between this study and that of Hege and Dodson (2004). Firstly, the presentation time of each picture and word was extended by two seconds for the child participants. Ghetti

et al. (2002) suggest that it is important to ensure that children are given sufficient time to encode and retrieve material. Secondly, some of the pictures and words were adapted and modified in order to be more age-appropriate to children's understanding. This measure, taken to make the current study comparable to Hege and Dodson's study with adults, was designed to reduce the likelihood that any differences between the two studies were due to methodological design (Brainerd, Reyna, and Forrest, 2002). For this reason, any minor differences between the two studies should be informative.

The experiment is modelled on the work of Hege and Dodson (2004) and compares false recall of words and pictures. There were two encoding conditions: half of the participants studied pictures while the other half studied words.

The retrieval instructions were manipulated in order to examine the predictions of both the distinctiveness heuristic and the impoverished relational-encoding accounts. Some participants received standard recall instructions while others received inclusion recall instructions in order to discriminate between the two accounts. Standard recall instructions involved participants only recalling the studied items. In contrast, inclusion recall instructions involved recalling both studied items and related items. Participants given inclusion recall instructions were then asked to go back through all the items that they had recalled and place a tick next to those items that they thought were actually presented during study. This constituted the post-recall recognition test. A further analysis was conducted from the data from participants in the inclusion recall instruction, in order to explore whether children used a distinctiveness heuristic during their post-recall recognition test. In addition to standard and recall instructions, a third group of participants received specific recall instructions designed to elicit specific pictorial information, in order to investigate whether the distinctiveness

heuristic may be applied at recall. Thus there were three retrieval instruction conditions: standard, inclusion, and specific instructions.

In the present experiment, the design differs from that of Ghatti, Goodman, and Qin (2002) in its distinctive presentation format, as this study presented pictures without accompanying written words. Although Ghatti et al. found that distinctive information reduced false memories in children aged 5 and 7, different trends may emerge in the current study due to the different presentation modality and the developmental age group. Ghatti et al. believe that it is unlikely that the children in their study implemented the distinctiveness heuristic, owing to young children's limited spontaneous metacognitive and strategic skills. The current study explores whether older children may have developed these skills, which would make it more likely that they would employ the distinctiveness heuristic as a decision rule. Hege and Dodson suggest that the distinctiveness heuristic may be applied at recall in a particular instruction condition. Therefore, the current research includes the specific instruction condition where participants only report items that elicit specific pictorial information in memory.

The specific instruction condition involves participants reporting only study items that they can remember seeing appear on the screen. If there is a larger difference between the two encoding conditions in the recall rates of the critical lures under the specific instructions than under the inclusion instructions, this would indicate that participants have used the distinctiveness heuristic as a retrieval strategy. Should this effect arise, it would demonstrate that participants given specific instructions edit out and withhold the reporting of critical lures as a result of studying pictures. In addition, it would provide evidence for the distinctiveness

heuristic being applied at recall. Hege and Dodson (2004) did not find that the distinctiveness heuristic was applied at recall.

The design is a between-groups design. When participants study both pictures and words, not remembering distinctive information about a test item may not necessarily mean that it is novel, but that the item was from one of the lists presented as words. In contrast, a between-groups design allows discrimination of studied words from non-studied words, as only studied words will bring to mind the associated pictorial information (Dodson & Schacter, 2002). This is elicited through recognition when the item is generated in the participants' recall attempt. The absence of pictorial information signifies that an item is new. However, the pictorial information is only available to those who are presented with pictures.

### ***1.6 Hypotheses***

1) It was expected that children would demonstrate a false memory effect. That is, that they would remember critical non-presented lure words that are associated with the study lists presented.

2) It was expected that studying pictures would reduce false memories in older children. That is, the effect of the distinctive encoding manipulation should be evident. Any reduction in errors and differences from studying pictures might be explained by the impoverished relational-encoding and distinctiveness heuristic accounts.

***Specific predictions for the impoverished relational-encoding account***

Two predictions derive from impoverished relational-encoding. First, participants given inclusion recall instructions were expected to report critical lures less often after picture encoding than after word encoding, under both standard and inclusion recall instructions. This is because the retrieval instructions cannot impact on the rate at which critical lures are reported if those lures do not come to mind in the first place. The second prediction concerns the probability of recalling studied items. Participants who studied words were expected to recall more studied items under inclusion instructions than under standard instructions. In contrast, participants who studied pictures were expected to show comparable rates of studied items under both the standard and inclusion instructions. This is because picture encoding reduces the inclination for participants to use relational information. Thus there is a predicted interaction between the encoding conditions and the retrieval instructions concerning the probability of recalling studied items (Hege & Dodson, 2004).

***Specific predictions for the distinctiveness heuristic account***

Three predictions derive from the distinctiveness heuristic account. First, it was expected that there would be a larger difference between the two encoding conditions in the recall rates of the critical lures under the standard instructions than under the inclusion instructions. Analyses of recall rates of the critical lures should show an interaction between the encoding condition and the retrieval condition. More specifically, results should show a difference in false recall rates of critical lures after picture encoding versus word encoding under the standard test instructions, but this difference should be reduced or eliminated under the inclusion recall instructions. Second, a further examination of the distinctiveness heuristic at recall would be achieved by exploring the differences between specific and inclusion instruction conditions. It was expected that there would be a larger difference between the



two encoding conditions in the recall rates of the critical lures under the specific instructions than under the inclusion instructions, as this pattern indicates that participants have used the distinctiveness heuristic as a retrieval strategy. The third prediction relates to the post-recall recognition test. This test concerns the proportion of studied items and critical lures, reported under inclusion instructions, which were later endorsed as having been presented in the encoding phase. Results were expected to demonstrate a significant effect of encoding, a significant effect of item type (studied items and critical lures) and an encoding  $\times$  item type interaction. Participants who studied pictures were expected to falsely recognise a significantly smaller proportion of critical lures than those participants who studied words. In addition, the rates of studied items in the two encoding conditions were expected to be comparable. These three predictions relate to the fact that participants who study pictures rather than words use a retrieval strategy to withhold reporting items that lack expected memorial information (Hege & Dodson, 2004).

3) The retrieval manipulation would have a significant effect on recall rates. Specifically, if students were assigned retrieval instructions in the standard recall condition then they would be expected to recall fewer critical lure words than those assigned to the inclusion recall condition. Further, if participants were given specific recall instructions then it was expected that they would recall the lowest number of critical lure words.

## 2.0 METHOD

Children ranging in age from 10-12 years studied DRM lists presented as either pictures or words on a projector screen. After a distractor task, participants were randomly assigned to recall the studied items following standard, inclusion, or specific instructions.

### *2.1 Participants*

Two hundred and forty-two children aged between 10 and 12 years (Year 7) were recruited from six intermediate schools in Christchurch, New Zealand. Principals were approached via letter (see Appendix 1), which usually resulted in a follow-up meeting. Participants were tested in classrooms in groups ranging from 9 to 35 students. Within each school, students were assigned at random to picture and word groups.

### *2.2 Apparatus and materials*

The words and pictures of Hege and Dodson (2004) were used in this experiment. Their picture stimuli were based on the pictures created by Israel and Schacter (1997), and the corresponding names for the items were based on the Roediger and McDermott (1995) word lists and on Russell and Jenkins' (1954) word-association norms.

The stimuli comprised 6 lists of 12 words, with each list related to a critical non-presented lure word. The 6 lists of words were presented in succession as 72 study items at a rate of five seconds per item. Half of the participants studied pictures while the other half studied words

(see Appendices 2 and 3). As the stimuli were presented, the researcher named each one of the 72 study items aloud (see Appendix 4).

A few words and pictures were modified to enhance the children's understanding. For example, pilot testing revealed that ten- and eleven-year-old children did not understand *stethoscope*, and *candy* was replaced with *lollies*, which is more common in New Zealand. The order of the six lists was randomized and all the participants received the words and stimuli in this same random order. The six lists each comprised 12 semantically related items which were presented in order of decreasing associative strength to the non-presented critical lure. The pilot study revealed that words relating to the critical lure *needle* did not produce strong associations or a false memory effect in the 10-12 age group. For this reason, a list relating to the critical lure *music* was included instead of the *needle* list. The *music* list was cited by Roediger, Watson, McDermott, and Gallo (2001) as one of the most effective lists in producing a false memory effect.

The pictures and words were projected from a laptop computer via a data projector to appear in the centre of a large white screen at the front of the room. Words were displayed in lower case 48 point Franklin Gothic Demi font. The pictures used were black-and-white line drawings varying in size and provided by Hege and Dodson. After pilot testing, some pictures were replaced with original black-and-white drawings in order to ensure children's recognition. Words and picture names were spoken by the researcher as each item was displayed.

The distractor task consisted of a “Haunted House Maze”, which was presented on an A3 page in greyscale format (see Appendix 5). The recall instructions were printed on A4 pages that participants turned over when instructed to do so (see Appendix 6 for instructions).

### ***2.3 Procedure***

Before testing was undertaken, ethical approval to conduct this research was obtained from the University of Canterbury Human Ethics Committee (see Appendix 7). Participants could only take part in the study if they returned a parental consent form (see Appendix 8).

Within each school, groups of students were first randomly assigned in equal numbers to picture and word groups. On arrival, each participant was brought into the classroom and introduced to the researcher and her assistant. Participants were then randomly assigned in equal numbers to one of the three instruction conditions. Each group was stationed in a different area of the classroom. Participants given standard recall instructions were asked to remember as many of the words or pictures as they could (see Appendix 6, i and ii). An inclusion recall instruction group was instructed to recall not only as many words or pictures as they could remember but also any related words that they could think of (see Appendix 6, iii and iv). After participants in this condition had recalled their items, they were asked to go through their recalled list and place a tick next to items that were presented during the study phase. Finally, those given specific recall instructions were asked to report only the items that they could remember seeing on the projector screen (see Appendix 6, v and vi).

Students were instructed to pay careful attention to the items they would see and hear, as a memory test would follow. The instructions were also presented on the large screen. Students assigned to the word-encoding condition were told that they would hear an item named and

see the word appear on the computer screen. Those assigned to the picture-encoding condition were told that they would hear the item named and see a picture of the item appear on the computer screen.

The study items were presented at a rate of one every five seconds. Participants were told that the six lists would be shown in succession without a break, and that it would take approximately six minutes for all the items to appear. They were also told that they were to be silent while the study items appeared on the screen.

After this study phase the participants were asked to turn over the A3 page on their desk and work on the “Haunted House Maze” for 5 minutes. Following this distractor task, participants were asked to turn over the piece of paper in front of them and respond to their own individual instructions printed on the sheet (see Appendix 6). The participants were told that they were to write the items they were asked to recall under test conditions where no talking was allowed. They were also told that they were not to look at the answers of pupils near them. Finally, they were told that the researcher would go around each group to check students’ understanding of the instructions. They were informed that each group had a different set of instructions and that they should concentrate on the instructions in front of them. Those in the inclusion instruction condition received additional instructions to go through their reported items and tick the items that they thought were actually presented to them during the study phase. This constituted the post-recall recognition task.

At the conclusion of the experiment the children were thanked for their participation. They were offered a small chocolate bar as a token of appreciation and were given a debriefing form to take home to their parents (see Appendix 9).

## 3.0 RESULTS

### *3.1 Group formation*

The encoding condition (picture vs word) and recall instruction (standard vs inclusion vs specific) were manipulated between subjects. The data were analysed using a between groups  $2$  (pictures vs words)  $\times$   $3$  (instruction condition) factorial design. Data from twelve of the 242 participants were excluded for the following reasons: failure to return parental consent forms; failure to follow instructions; or obvious displays of cheating. The remaining 230 participants fell into the six groups of between 32 and 44 subjects.

### *3.2 Reporting of critical lure words*

A single sample t-test was conducted for each of the six groups to test the rate that critical lures were reported against the hypothesis that no critical lure words would be remembered. Analyses determined that all groups were significantly different from zero (see Table 1). This result supports the first hypothesis that children were demonstrating a false memory effect, as indicated by their recall of critical non-presented lure words.

Table 1

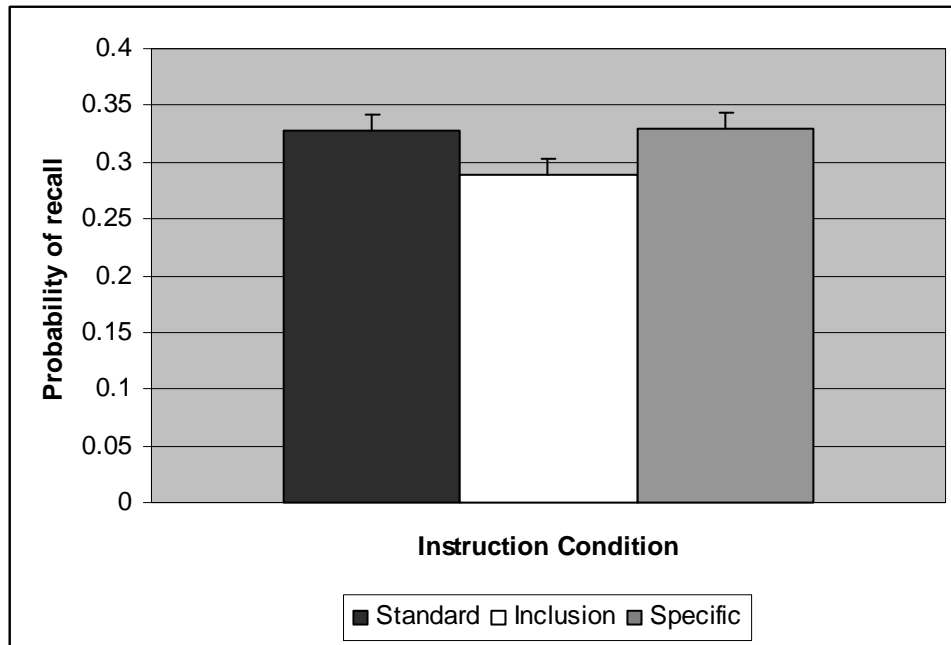
*Critical lure error rates in the six instruction conditions*

	Mean	Std.Dv.	N	Std.Err.	t-value	df	p
<hr/>							
Pictures							
Standard	0.13	0.14	38	0.02	5.52	37	<.001
Words							
Standard	0.12	0.14	38	0.02	5.24	37	<.001
Pictures							
Inclusion	0.26	0.20	37	0.03	7.86	36	<.001
Words							
Inclusion	0.29	0.20	38	0.03	8.75	37	<.001
Pictures							
Specific	0.23	0.49	38	0.08	2.86	37	<.01
Words							
Specific	0.15	0.16	38	0.03	6.03	37	<.001
<hr/>							

### ***3.3 Recall rates of studied items that were presented in word lists***

The recall rates of studied items were analysed to test the predictions of the impoverished relational-encoding account. This analysis involved exploration of the recall rates of items from the 72 stimuli in the study lists under the three instruction conditions (standard, inclusion, and specific). A 2 (encoding condition: picture vs word)  $\times$  3 (test instructions: standard vs inclusion vs specific) ANOVA was used to examine the recall rates of the studied items. This analysis produced a significant effect of test instructions,  $F(2, 225) = 4.40$ ,  $p < 0.05$ . The main effect of encoding was not significant,  $F(1, 225) = 0.17$ ,  $p > 0.70$ . In addition,

there was no significant interaction between encoding and retrieval conditions,  $F(2, 225) = 2.13, p > 0.1$ . The probabilities of recalling studied items are presented in Figure 1.



*Figure 1.* Probability of recalling studied items under standard, inclusion, and specific instruction conditions collapsed across picture- and word-encoding conditions. Vertical bars indicate the standard error of the mean.

Although there was no significant interaction, specific effects were predicted between encoding and retrieval conditions. Therefore, a post hoc Tukey HSD test for unequal N revealed that only one difference was significant between recall instructions at the .05 level. This was between the word-inclusion instruction group ( $M = 0.25$ ) and the word-specific instruction group ( $M = 0.35$ ). There were no statistically significant differences as a function of instruction condition under picture-encoding conditions (all  $p$  values  $> .20$ ). This pattern of results does not fit the predictions of the impoverished relational-encoding account. As there was no significant effect of encoding nor any significant interaction between encoding and



retrieval conditions, the results do not demonstrate impaired acquisition of relational information during picture encoding.

### ***3.4 Critical lure recall rates***

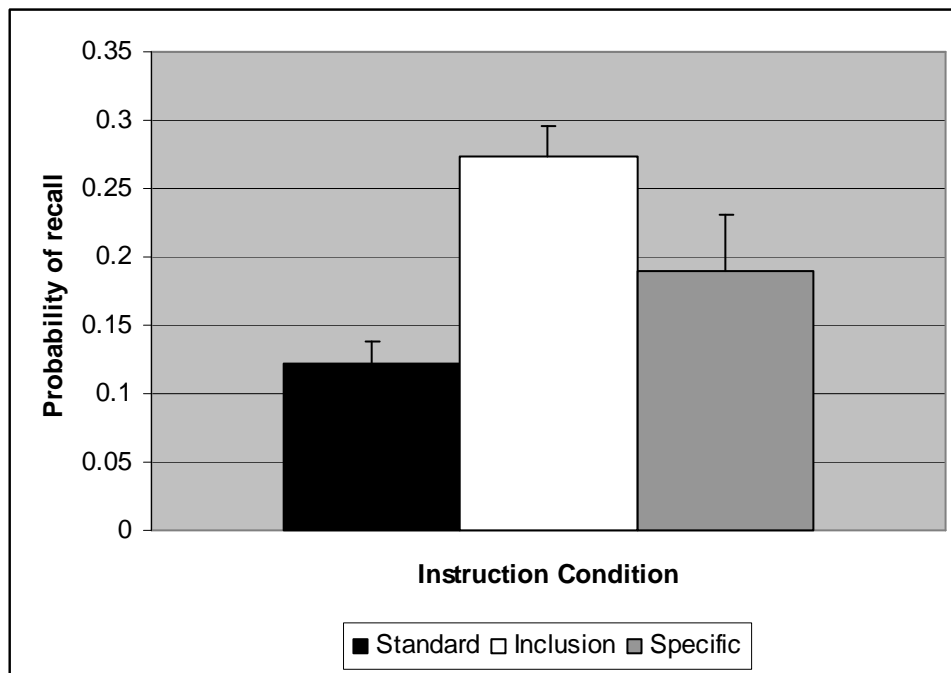
The critical lure recall rates under the three instruction conditions are displayed in Figure 2. A 2 (encoding condition: picture vs word)  $\times$  3 (instructions: standard vs inclusion) ANOVA conducted on the rate at which critical lures were recalled yielded significant main effects of the test instructions,  $F(2, 225) = 6.13, p < .01$ . More critical lures were reported under the inclusion instructions than under standard instructions. In addition, fewer critical lures were reported under the specific instruction condition than under the inclusion instruction condition. There was no significant main effect of the encoding condition: rates of critical lures were comparable for pictures and words,  $F(1, 225) = 1.17, p > 0.2$ , with marginally higher overall recall rates in the picture condition than in the word condition. There was no significant interaction between retrieval and encoding conditions,  $F(2, 225) = 0.81, p > 0.4$ .

Specific predictions were given relating to the impoverished relational-encoding account and the distinctiveness heuristic account. Therefore, a post hoc Tukey HSD test for unequal N revealed only one difference was significant at the .05 level, which was between the word-standard instruction group ( $M=0.11$ ) and the word-inclusion instruction group ( $M=0.27$ ). No other differences were statistically significant.

The impoverished relational-encoding account was not supported, as participants given inclusion recall instructions did not report critical lures less often after picture encoding than after word encoding under both standard and inclusion recall instructions. In addition, the

distinctiveness heuristic account was not supported, as there was not a larger difference between the two encoding conditions in the recall rates of the critical lures under standard instructions than under the inclusion instructions.

These results do not suggest that critical lures are less likely to come to mind after picture encoding than after word encoding. Therefore they fail to lend support to either the impoverished relational-encoding or the distinctiveness heuristic account. Instead, the results appear to indicate that children do not show reduced false memories by studying pictures as opposed to words.



*Figure 2.* Probability of recalling critical lures under standard, inclusion, and specific instruction conditions collapsed across picture- and word-encoding conditions. Vertical bars indicate the standard error of the mean.

### 3.4.1 *Specific recall*

The only evidence for the distinctiveness heuristic in Hege and Dodson's two experiments came from the post-recall recognition task. They suggest that the distinctiveness heuristic may be applied at recall if participants are given test instructions that emphasize reporting only items that elicit pictorial information. Therefore, the specific instruction condition was added to the present experiment to explore whether the distinctiveness heuristic would be applied at recall.

According to the distinctiveness heuristic account, there will be a greater difference between words and pictures in the recall rates of the critical lures under the specific instructions than under the inclusion instructions. Participants were expected to remember many more critical lures in the inclusion instruction condition. Average probabilities of the critical lure ratings were compared between the specific instruction condition and the inclusion instruction condition, in order to explore whether the distinctiveness heuristic was applied at recall. The distinctiveness heuristic was not applied at recall, as there was not a greater difference between the two encoding conditions in the recall rates of the critical lures under the specific pictorial instructions than under the inclusion instructions. Recall rates of the critical lures did not show an interaction between the encoding condition and the retrieval condition as the distinctiveness heuristic account predicts,  $F(1, 158) = 0.97, p = 0.32$ .

The average probability trends of the critical lure ratings in the specific and inclusion instruction conditions were not consistent with what was predicted. It was expected that there would be a larger difference between the two encoding conditions in the recall rates of the

critical lures under the specific instructions than under the inclusion instructions. This finding did not emerge, so the results fail to support the distinctiveness heuristic account.

### ***3.5 Post-recall recognition rates***

Participants in the inclusion instruction condition were instructed to go through the items they had recalled and place a tick next to the items they recognized from the encoding phase. This post-recall recognition test was used to explore whether children would use a distinctiveness heuristic. This analysis concerns the proportion of studied items and critical lures that participants reported under the inclusion instruction condition. A 2 (encoding condition: picture vs. word)  $\times$  2 (item type: studied items vs critical lures) repeated measures ANOVA was conducted on the proportion of studied items and critical lures reported under the inclusion instructions and then endorsed as having been presented during the encoding phase (see Figure 3). The ANOVA produced a significant effect of item type,  $F(1, 66) = 91.56, p < 0.01$ . There were no significant main effects of encoding,  $F(1, 66) = 0.69, p > 0.4$  n.s and no significant encoding by item type interaction,  $F(1, 66) = 0.05, p > 0.4$ .

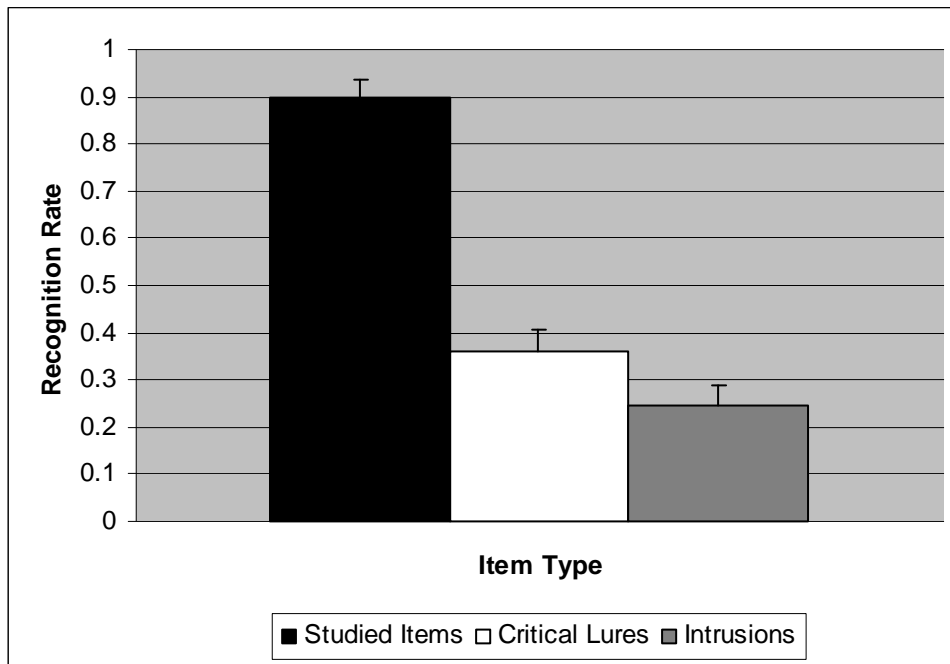


Figure 3. Post-recall recognition rates of both the true recognition rates of studied items and false recognition rates of critical lures and non-critical intrusions collapsed across picture- and word-encoding conditions.<sup>1</sup> Vertical bars indicate the standard error of the mean.

Rates of false recognition for critical lures were comparable in both picture (37%) and word (35%) conditions. In addition, studied items that were correctly recognized by participants in word- and picture-encoding conditions were almost identical (90% and 89.9% for word- and picture-encoding conditions respectively). The number of non-critical intrusions falsely recognized in the post-recall recognition test by those studying words (18%) was fewer than those who studied pictures (31%), but this difference just failed to reach significance,  $t(58) = 1.90, p = 0.06$ .

<sup>1</sup> Studied items and critical lures are presented as proportions (i.e., the average frequency out of 72 and 6, respectively). In contrast, the intrusions represent a proportion of how many non-critical intrusions participants made during recall which were subsequently endorsed during recognition. For example, if a participant reported 5 non-critical intrusions during the recall phase and then claimed that 1 of those items was 'old' during the recognition phase, his/her non-critical intrusion recognition rate was 0.2.

This pattern of results is not consistent with the predictions of the distinctiveness heuristic, as there was no significant effect of encoding, nor any significant interaction between encoding and item type. The account expects participants who study pictures to falsely recognize a significantly smaller proportion of critical lures than those participants who studied words. It also expects the rates of studied items in the two encoding conditions to be comparable. In contrast to the predicted patterns, participants studying pictures did not falsely recognise significantly fewer critical lures than did the participants studying words.

## 4.0 DISCUSSION

Four clear results emerged from the present study. Firstly, eleven-year-old children demonstrated a false memory effect, but their overall average false critical lure recall ratings were just over half the level of typical adult rates from other comparable studies. Secondly, participants who studied pictures did not make significantly fewer false memory errors than participants who studied words, which demonstrated that distinctive information did not reduce false memories in 11-year-old children. Thirdly, factorial analyses revealed a significant effect of test instructions. This was indicated in the differences in the reporting of critical lures in the three instruction conditions (standard, inclusion, and specific recall). Finally, children do not appear to reduce false memories in a manner consistent with adults, nor can the results be explained in terms of two accounts that have been proposed to explain reduced false memories in adults (the impoverished relational-encoding account and the distinctiveness heuristic account).

### *4.1 The false memory effect in children*

The first hypothesis predicted that children will demonstrate a false memory effect by remembering critical non-presented lure words associated with the study lists presented. The results supported the first hypothesis, as children with an average age of 11.5 years recalled pictures and words that were not presented to them but which were semantically associated with the presented stimuli. Critical lure recall ratings ranged from 12% to 29%, averaging 19.6%. These recall rates approximate to about half of the adult percentage typically reported. For example, Hege and Dodson's overall average critical lure recall rate was 37.5%. In 2002, Brainerd, Reyna, and Forrest reported a similar finding in their third experiment, when the

eleven-year-olds' false recall percentage of critical non-presented words was less than half of the adults' percentage.

One possible explanation for this difference concerns the degree to which semantic networks are activated by a particular concept in adults, compared to children. Bjorklund (2000) suggests that every item in semantic memory is represented by nodes which are connected by links. Relations between individual nodes can be strengthened by additional encounters with items during development. In turn, frequently encountered items are more readily accessed at the time of retrieval. According to Bjorklund (1987), "age differences in semantic memory affect the ease with which information in permanent memory can be activated, which in turn influences the amount of mental effort available for other cognitive operations" (Bjorklund, 1987, p. 93). On average, eleven-year-old children will undoubtedly have a more limited semantic network compared with adults (Schneider & Bjorklund, 2001). Greater activation of interrelated nodes in memory may explain the higher rates of false memory errors in adults relative to children. This places the findings in line with a spreading activation account, which has the premise that false recall should increase as the total amount of activation for the critical item increases (Roediger, Balota, & Watson, 2001).

As children develop, the number and strength of their associations and their knowledge of features of items increase (Schneider & Bjorklund, 2001). An increasing knowledge base with subsequent strengthened connections among items makes it easier to activate related items after one item in a domain is activated (Schneider & Bjorklund, 2001). Adults may be producing higher recall rates of false memories due to the activation of their increased semantic network. Generally, false levels of recall increase with age (Bjorklund & Muir, 1988). This indicates that cognitive development from older adolescents to adults is



influential regarding false memory outcomes in the DRM paradigm, and the present results appear to be consistent with this perspective.

Nevertheless, past research has demonstrated that eleven-year-old children do adopt at least some semantic-processing strategies, such as elaboration and organization. It is thought that these strategies aid in the ability to extract the gist of individual words and to connect this meaning across multiple words (Bjorklund, 1999; Bjorklund & Muir, 1988; Brainerd, Reyna, & Forrest, 2002). Young children appear to be limited in their ability to spontaneously connect gist in the way that older children have demonstrated (Bjorklund, 1978). These semantic-processing strategies appear to play a vital role in the DRM illusion, as demonstrated by Brainerd, Reyna, and Forrest's (2002) finding that the level of false recall in children increased from age 7 to age 11.

Generally, older children have more knowledge and prior experience than younger children, and therefore have a greater knowledge base, which can improve their ability to learn and remember (Shaffer, 2002). This knowledge base is a factor that can enhance memory performance between younger and older children, and between older children and adults. More detailed knowledge can result in improved memory performance, because it is easier to retrieve information that is well established (Bjorklund, 1987; Kee, 1994; Shaffer, 2002). Older children's expanding knowledge base can contribute to their developing ability to categorize and elaborate on information compared to younger children. The premise that eleven-year-old children are able to spontaneously extract gist places the findings in line with fuzzy-trace theory, which postulates that there are important developmental differences in the way children encode information (Shaffer, 2002). The ability to spontaneously connect gist undergoes an extended period of development. For this reason, the DRM paradigm can

produce large developmental increases and age variability in verbatim and gist memory (Brainerd, Reyna, & Forrest, 2002).

#### ***4.2 The effect of studying distinctive information***

The second hypothesis predicted that children who were designated to study pictures would make fewer critical lure errors than children studying words, thus demonstrating the effect of studying distinctive information. Surprisingly, the second hypothesis was not supported. That is, participants in the picture-encoding condition did not make significantly fewer errors than participants in the word-encoding condition. Distinctive information can potentially decrease the memorial information which is elicited by the critical lure (Hege & Dodson, 2004). This result fails to lend support to the theory that using distinctive information reduces false memories in children.

An additional finding relating to differences in the encoding conditions was that studying pictures did not demonstrate superior recall of the true studied items. More specifically, analyses conducted on the proportion of true recalled items from the 72 studied items revealed no statistically significant main effects of encoding, nor any significant interaction between encoding and retrieval conditions. This finding followed the same pattern found in the false critical lure recall rate. It appears that children at this particular developmental period are encoding and/or retrieving information in a different manner to adults. In this study, the use of pictures has not demonstrated a superior effect in the subjects' ability to remember studied items and make fewer false memory errors. Therefore the results cannot be explained in terms of the impoverished relational-encoding and distinctiveness heuristic accounts.

This null finding is explored by addressing three different interpretations: the floor effect, 11-year-olds' semantic networks, and fuzzy-trace theory. The floor effect makes reduced memories in this group of children less likely, as the percentage of false recall in this group is already low. The children's false memory recall rates in the current study were much lower than the adult rates found by Hege and Dodson. The influence of the encoding condition (studying pictures versus studying words) may not have been accurately reflected in the dependent variables, because children's variability (range of responses) is likely to be higher compared to adults. Distinctive information may not have been able to reduce false memories in children, because their recall rates were already at a low level.

More speculatively, it is also possible that older children are not demonstrating differences between picture and word processing as has been seen in adults, because adults have larger semantic networks than children. Research has demonstrated that children show differences in picture-word effects relative to adults, affected by children's lower levels of vocabulary and semantic networks relative to adults (e.g., Theios & Amrhein, 1989). For example, Greenham and Stelmack (2001) demonstrated that older children (aged from nine to thirteen) showed a greater attentional demand when naming pictures than adults did. Their study highlights the additional processing involved in naming pictures.

The finding that participants studying pictures did not show reduced false memories compared to participants studying words is consistent with fuzzy-trace theory. Application of this theory has shown that pictorial stimuli do not automatically suppress false memories in subjects (C.J. Brainerd, personal communication, March 1, 2006). The child participants in this study may not have processed the pictorial information in the same way as adults would (C.J. Brainerd, personal communication, March 1, 2006). Fuzzy-trace theory predicts

different developmental patterns in false memories between children and adults in terms of participants' ability to store and process gist memories during recall or recognition. The differences in false recall rates after studying DRM lists between older children and adults has been demonstrated by Brainerd et al. (2002) and the current study. In addition, these lowered levels of false memories make it difficult to see a difference in the encoding of pictures and words.

In contrast to most findings with adults, Koutstaal and Schacter (1997) found that both younger adults and older adults often made false recognition errors when studying pictures. This demonstrates that using distinctive stimuli can still result in false memory errors, which is consistent with the current findings.

Contrary to the current findings, Ghetti, Goodman, and Qin (2002) found that distinctive information reduced the rate of false memories in five- and seven-year-old children. Ghetti et al.'s findings also differed from those of Brainerd, Reyna, and Forrest (2002), in that they found a decrease in false recall of critical lure words from 35% in 5-year-olds to 19% in 7-year-olds. Brainerd, Reyna, and Forrest, (2002) had shown false recall of critical lures increased between childhood and adolescence. Ghetti et al. presented short DRM lists with 7 words as opposed to the more usual 15 words. Brainerd, Reyna, and Forrest (2002) have noted that Ghetti et al.'s different procedures may have reversed the developmental trends in the false-memory effect, and could explain why Ghetti et al. showed a decrease in false recall from 5 year olds to 7 year olds. For this reason, it is possible that the differences between the current study and that of Ghetti et al. could also be the result of procedural methods. The lists in this study consisted of either 12 words or pictures. Future research should address this

discrepancy and the effect of procedural modifications by systematically varying the list length for children in different age ranges.

#### ***4.3 Manipulation of retrieval instructions***

The final hypothesis tested concerned the effect of the manipulation of the retrieval instructions. It was expected that students assigned to the standard recall instructions would report fewer critical lure words than students assigned to the inclusion recall instructions. Further, the smallest number of critical lure words should be reported in the specific recall condition, where students are asked to solely recall either the pictures or words that they remember seeing on the projector screen.

Partial support was found for the third hypothesis relating to the effect of manipulation of the retrieval instructions. As expected, the probability of recalling critical lures was highest in the inclusion recall instruction condition. Contrary to predictions, the smallest recall rates of critical lures occurred in the standard recall instruction condition, not in the specific recall instruction condition (see Figure 2). These significant findings indicate that the test instructions had the potential to alter children's recall at the time of retrieval.

A surprising result was found relating to the specific instruction condition. It was expected that participants in this condition would report the smallest number of critical lure words in both encoding conditions, owing to the instructions' purpose of eliciting specific remembered information. In contrast to the hypothesis, the smallest number of critical lure words was reported in the standard recall instruction condition.

As demonstrated by the mean standard error bars in Figure 2, there was considerable variability from participants in this retrieval condition. This suggests that the specific instruction condition did not have the desired effect, and may not have been measuring what it was intended to measure. Given the error, it's possible that this result was some product of the data.

Results may have been affected by the testing conditions. Participants were tested in class groups. Subjects in the specific pictorial instruction condition had fewer words to write on their answer sheets. They may have been influenced by members of other instruction groups in the same room who had a considerable number of recalled answers to record. In this way, the children may have been behaving in what they perceived to be a socially-desirable way, by recording as much as they could remember. Future research could involve testing participants individually in order to examine this retrieval condition more effectively.

#### ***4.4 Differences in reducing false memories between children and adults***

Finally, one of the major aims of the study was to examine the differences in the study of distinctive information between children and other studies involving adults. Hege and Dodson (2004) found that studying distinctive information (in the form of pictures) leads to reduced false memory errors. Their results are consistent with the accounts that explain why studying pictures leads to reduced false memories. An open empirical question was whether children would show reduced false memories in a way that was consistent with the impoverished relational-encoding account and/or the distinctiveness heuristic account. Inclusion recall was selected for the study, as it has been a more effective measure of the impoverished relational-encoding account than inclusion recognition. Inclusion recall is a way of measuring whether encoding distinctive information reduces the likelihood of critical lures coming to mind. The

impoverished relational-encoding account predicts that picture encoding will produce lower rates of critical lure recall than will word encoding in both standard recall and inclusion recall instruction conditions (Hege & Dodson, 2004). Although marked differences were found between the two instruction conditions, critical lure recall rates were comparable in both encoding conditions. Therefore the study did not provide evidence for the impoverished relational-encoding account. Children who studied pictures did not make fewer false memory errors than children who studied words. In this way, the current study did not find support for the notion that distinctive information reduces false memories in eleven-year-old children.

According to the distinctiveness heuristic account, participants who receive standard recall instructions are thought to make fewer critical lure errors in the picture-encoding condition than in the word-encoding condition. In contrast to the expectations of the impoverished relational-encoding account, the distinctiveness heuristic account predicts no significant differences in studying pictures relative to studying words in the inclusion recall instruction condition. This pattern of findings demonstrates how manipulating the retrieval instructions can show how the distinctiveness heuristic can be turned on and off. In other words, responding to specific instructions can potentially suppress false memory errors. Therefore, the current findings did not support the distinctiveness heuristic account, as there were no significant encoding differences in either the standard or inclusion instruction conditions.

The distinctiveness heuristic was examined in two other ways: through the post-recall recognition test and through the specific pictorial instruction condition. Hege and Dodson (2004) found evidence for the distinctiveness heuristic account in the post-recall recognition test, as their participants who studied pictures reported significantly fewer critical lures than participants who studied words. In contrast, children in the post-recall recognition test in the

current study did not demonstrate any significant differences in the rates of false recall of critical lures across picture and word conditions, indicating that the distinctiveness heuristic was not applied by children.

Finally, the additional instruction condition (specific) was designed to test whether the distinctiveness heuristic may be applied at recall. Hege and Dodson (2004) only found support for the distinctiveness heuristic in the recognition test. If recall rates between the two encoding conditions were greater under the inclusion instructions than under the specific pictorial instructions, this would demonstrate the use of this heuristic. The distinctiveness heuristic account predicts an interaction between the encoding condition and the retrieval condition of the critical lures. The findings demonstrate that the distinctive heuristic was not applied at recall, not even in the new instruction condition. Therefore, eleven-year-old children did not appear to apply a distinctiveness heuristic at either recall or post-recall recognition. This result was also found by Ghetti et al. (2002), although they used much younger subjects (five- and seven-year-olds). It appears that older children have not yet developed the metacognitive strategies to aid their use of this retrieval strategy.

Metacognition is thought to develop around the age of eleven years. Children's metamemorial knowledge has been shown to increase with age (Schneider & Pressley 1997; Schneider & Bjorklund, 2001).

The impoverished relational-encoding account and the distinctiveness heuristic account were tested through the manipulation of the instruction conditions. Although the results did not lend support to either of these accounts, there was a significant difference in the three retrieval instruction conditions. The manipulation of the instruction condition and the influence on the



recall task indicate how children can effectively be influenced into producing a higher or lower false memory effect.

#### ***4.4.1 Comparisons with adults (Hege & Dodson, 2004)***

To assist in evaluating the present results with children, it is useful to contrast them with the previous results with adults reported by Hege and Dodson. Some similarities between the two studies were found in the critical lure recall rates. Both studies yielded significant main effects of test instructions, as more critical lures were reported under the inclusion instructions than were reported under the standard instructions. The major difference between the two studies was that Hege and Dodson found a significant main effect of encoding which was not found in the current study. Hege and Dodson reported many more critical lures being recalled by participants who studied words than were recalled by those who studied pictures. The current study differed, as it resulted in a similar number of critical lures being produced by participants studying words and pictures, disconfirming the hypothesis that children will make fewer critical lure errors when studying pictures than when studying words. As there was no significant interaction between encoding condition and retrieval condition, the current findings fail to support the distinctiveness heuristic account. Contrary to the predictions of the distinctiveness heuristic account, there were no significant differences between the two encoding conditions in the recall rates of critical lures under the standard instructions and under the inclusion instructions.

It is also helpful to examine the studied item recall rates of the two studies. Hege and Dodson reported a marginally significant effect of the test instructions, and a significant interaction. The current results replicate the significant effect of the test instructions, but in contrast with Hege and Dodson, do not conform to a significant interaction. This failure to find an

interaction means that the results are not consistent with the impoverished relational-encoding account, which predicts an interaction between encoding condition and retrieval instructions in terms of the rates at which studied items are recalled. Contrary to the findings of Hege and Dodson, in this experiment participants who studied words did not report greater numbers of studied items under inclusion instructions than under standard instructions.

Finally, there were differences found in the two studies concerning the true recognition rates of studied items and false-recognition rates of critical lures on the post-recall recognition test. Hege and Dodson's research yielded a significant effect of item type relating to the proportion of studied items and critical lures which was reported under the inclusion instructions and was later confirmed as having been presented during the encoding phase. This finding was comparable to the results of the current study with children.

Hege and Dodson also found a significant effect of encoding and a significant encoding by item type interaction. In the inclusion instruction condition, participants who studied pictures recognized significantly fewer false critical lures than subjects who studied words. These significant differences as a function of instruction condition under picture-encoding conditions provided evidence for the distinctiveness heuristic account contributing to the reduction in false memories after picture encoding.

In direct contrast, in the inclusion instruction condition of the present study there were no significant differences between participants who studied pictures and words in the recognition of critical lures. The results from the post-recall recognition test do not display a reduction in false memories after picture encoding. For this reason, the results of the post-recall recognition recall task do not support the distinctiveness heuristic account.

#### *4.5 Limitations of this study*

There are several limitations which could have affected the results. Difficulties arose from testing children. Within each testing group there were some children who had trouble concentrating and paying attention while all the study items were presented. Students vary in their ability to concentrate. It is extremely difficult to verify that all participants paid attention to all the study items. On occasion, the researchers noticed a few students who looked at the screen for a partial period of the study time only.

It is possible that the length of presentation rate affected the children's ability to concentrate. The rate of presentation of the study items is a variable which could have impacted on the results. The stimuli were presented to the children for two seconds longer than to the adult subjects in earlier studies. According to Roediger, McDermott, and Robinson (1998), predicting the effect of presentation rate on false recall is difficult. False recall can be attributed to both slower presentation and faster presentation. Slower presentation may enhance false recall due to deeper processing, involving elaborative and relational processing. In contrast, faster presentation may make it difficult to encode individual items, leading to participants extracting overall themes of lists rather than specific items. The general consensus in the literature from recent data suggests that false recall rates are higher when the rate of presentation is faster (Roediger, McDermott, & Robinson, 1998).

Children were tested in classrooms in order to cause the least amount of disturbance for schools and for efficiency, due to testing such large numbers. Although strict instructions and warnings about cheating were given, there were still some obvious instances of cheating. Data from those students were excluded from analysis. However, it is possible that other instances were not observed.

Finally, children were given explicit instructions both verbally and visually. Students were given a specific recall task on a piece of paper in front of them on their desk (See Appendix 6). After reading the instructions, the researcher and her assistant went around all groups of students and checked for understanding of instructions, elaborating where necessary. Although students would confirm that they understood the instructions, there were occasions when their answer sheets would suggest otherwise. Instructions were adjusted after pilot testing to ensure they would be appropriate for this particular age group. However, it was not possible to ensure that all children understood their instructions or followed them exactly.

#### ***4.6 Conclusions and implications***

The current study demonstrated the complex role of encoding and retrieval mechanisms in older children's memory processes. Children were found to be susceptible to retrieval manipulation. This was demonstrated by the rates of recall of critical lure words differing depending on instruction conditions. The study's main aim was to explore whether using distinctive information would reduce false memories in children. In contrast with the literature, participants who studied pictures did not make fewer false errors than participants who studied words. Therefore, the current findings can not be explained in terms of two accounts which have been shown to reduce false memories in adults: the impoverished relational-encoding account and the distinctiveness heuristic.

It is evident that children are not using the same encoding and retrieval processes to reduce false memories as adults. Future research needs to explore these developmental differences further. At what stage do older children's memory mechanisms resemble those of adults?

Comparisons with adult findings suggest that eleven-year-old children's extensive processing is not as developed as adults', and their knowledge base, including semantic networks, has not fully developed.

Research has demonstrated differences in the processing of pictures in comparison to words (e.g., Potter & Faulconer, 1975; Smith & Magee, 1980). The current study found no significant differences between the encoding conditions, indicating that children are processing pictorial information in a different manner to adults. Eleven-year-olds' false recall of critical lure reporting was just over half that of adults, placing the findings in line with those of Brainerd, Reyna, and Forrest (2002) with this age group. This lowered level of false memory errors may have occurred due to a smaller knowledge base and semantic network compared to adults, which may be consequently contributing to comparable rates of critical lures in picture- and word-encoding conditions. This account is in line with fuzzy-trace theory, which is helpful in its description of developmental changes in encoding (Shaffer, 2002). As gist traces represent meaning, this highlights the role of semantic information in memory. Older children have shown increased development in their semantic abilities by the age of eleven, but their semantic processes are not thought to have fully developed. This may explain why the results demonstrated different findings to those which have been found with adults.

The current study gives insight into the complex role of older children's memory. The implications of the research suggest key developmental differences in the way older children study distinctive information in the form of pictures, compared to younger children and adults. Howe (1998) suggests that distinctiveness is measured against our own knowledge and experience. This being so, it may be that children, who have a more limited number of stored

experiences, may not make sharp distinctions between types of stimuli stored in memory.

Future research could further explore developmental differences in children's memory from the age of 11 to young adulthood. In addition, research could explore the conditions whereby eleven-year-old children are able to reduce false memories from the study of distinctive information.

## REFERENCES

- Anderson, R.E. (1984). Did I do it or did I only imagine doing it? *Journal of Experimental Psychology: General*, 113, (4), 594-613.
- Arndt, J., & Reder, L.M. (2003). The effect of distinctive visual information on false recognition. *Journal of Memory and Language*, 48, 1-15.
- Baddeley, A. (2001). "Memory". In R. A. Wilson, & F.C. Keil (Eds.), *The MIT Encyclopedia of the Cognitive Sciences*. Cambridge, MA: MIT Press.
- Bartlett, F.C. (1932). *Remembering*. Cambridge: Cambridge University Press.
- Bjorklund, D.F. (2000). *Children's thinking: Developmental function and individual differences* (3<sup>rd</sup> ed.). Pacific Grove, CA: Brooks/Cole.
- Bjorklund, D.F. (1987). How age changes in knowledge base contribute to the development of children's memory: An interpretive review. *Developmental Review*, 7, 93-130
- Bjorklund, D.F. (1978). Negative transfer in children's recall of categorized materials. *Journal of Experimental Child Psychology*, 26, 299-307
- Bjorklund, D. F., & Muir, J.E. (1988). Children's development of free recall memory: Remembering on their own. *Annals of Child Development*, 5, 79-123.
- Brainerd, C. J., & Reyna, V.F. (2004). Fuzzy-trace theory and memory development. *Developmental Review*, 24, 396-439.
- Brainerd, C. J., & Reyna, V.F. (1998a). Fuzzy-trace theory and children's false memories. *Journal of Experimental Child Psychology*, 71, 81-129.
- Brainerd, C. J., & Reyna, V.F. (1998b). When things that were never experienced are easier to "remember" than things that were. *Psychological Science*, 9,(6), 484-489.
- Brainerd, C.J., & Reyna, V.F. (1996). Mere memory testing creates false memories in children. *Developmental Psychology*, 32, 467-478.
- Brainerd, C.J., Reyna, V.F., & Forrest, T.J. (2002). Are young children susceptible to the false-memory illusion? *Child Development*, 73 (5), 1363-1377.
- Brainerd, C. J., Reyna, V.F. & Kneer, R. (1995). False-recognition reversal: when similarity is distinctive. *Journal of Memory and Language*, 34, 157-185.
- Brainerd, C.J., Wright, R., Reyna, V.F. & Payne, D.G. (2002). Dual retrieval processes in free and associative recall. *Journal of Memory and Language*, 46, 120-152.
- Braun, K.A. (1999). Post-experience advertising effects on consumer memory. *Journal of Consumer Research*, 2, 319-334

- Braun-LaTour, K. A., LaTour, M.S., Pickrell, J.E., & Loftus, E.F. (2004). How and when advertising can influence memory for consumer experience. *Journal of Advertising*, 33(4), 7-25.
- Braun, K.A., Ellis, R. & Loftus, E.F. (2002). Make my memory: how advertising can change our memories of the past. *Psychology and marketing*, 19 (1) , 1-23
- Brewer, W. F., & Treyens, J.C. (1981). Role of schemata in memory for places. *Cognitive Psychology*, 14, 207-230.
- Brown, N. R., Buchanan, L., & Cabeza, R. (2000). Estimating the frequency of nonevents: The role of recollection failure in false recognition. *Psychonomic Bulletin & Review*, 7, 684-691.
- Brown, J. L., Lewis, V.J., & Monk, A.F. (1977). Memorability, word frequency, and negative recognition. *Quarterly Journal of Experimental Psychology*, 29, 461-473.
- Budson, A.E., Droller, D.B.J., Dodson, C.S., Schacter, D.L., Rugg, M.D., Holcomb, P.J. & Daffner, K.R. Electrophysiological dissociation of picture versus word encoding: The distinctiveness heuristic as a retrieval orientation. *Journal of Cognitive Neuroscience*, 17 (8), 1181-1193
- Clark, S. E., & Gronlund, S.D. (1996). Global matching models of recognition memory: How the models match the data. *Psychonomic Bulletin & Review*, 3(1), 37-60.
- Collins, A., Warnock, E.H., Aiello, N. & Miller, M.L. (1975). Reasoning from incomplete knowledge. In D. Bobrow & A. Collins (Eds.), *Representation and understanding: Studies in cognitive science* (383-415). New York: Academic Press.
- Craik, F. I. M. & Lockhart, R.S. (1972). Levels of Processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, 11, 671-684.
- Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology*, 58, (1), 17-22
- Dewhurst, S.A., & Robinson, C.A. (2004). False memories in children: evidence for a shift from phonological to semantic associations. *Psychological Science*, 15 (1), 782- 786
- Diliberto-Macaluso, K. A. (2005). Priming and false memories from Deese-Roediger-McDermott lists on a fragment completion test with children. *The American Journal of Psychology*, 118(1), 13-28.
- Dodson, C. S., Koutstaal, W. & Schacter, D.L. (2000). Escape from illusion: reducing false memories. *Trends in Cognitive Sciences*, 4(10), 391-397.
- Dodson, C. S., & Schacter, D.L. (2002). When false recognition meets metacognition: The distinctiveness heuristic. *Journal of Memory and Language*, 46, 782-803.



- Dodson, C. S., & Schacter, D.L. (2001). "If I had said it I would have remembered it": Reducing false memories with the distinctiveness heuristic. *Psychonomic bulletin & review*, 8, 155-161.
- Einstein, G. O. & Hunt, R.R. (1980). Levels of processing and organization: Additive Effects of individual-item and relational processing. *Journal of Experimental Psychology: Human Learning and Memory*, 6(5), 588-598.
- Foley, M. A., Johnson, M.K., & Raye, C.L. (1983). Age-related changes in confusion between memories for thoughts and memories for speech. *Child Development*, 54(51-60).
- Gentner, D., & Collins, A. (1981). Studies of inference from lack of knowledge. *Memory & Cognition*, 9, 434-443.
- Ghetti, S., Goodman, G.S. & Qin, J. (2002). False memories in children and adults: Age, distinctiveness, and subjective experience. *Developmental Psychology*, 38(5), 705-718.
- Greenberg, D. L. (2004). President Bush's false 'Flashbulb' memory of 9/11/01. *Applied Cognitive Psychology*, 18, 363-370.
- Greenham, S.L., & Stelmack, R.M. (2001). Event-related potentials and picture-word naming: Effects of attention and semantic relation for children and adults. *Developmental Neuropsychology*, 20 (3), 619-638
- Hege, A. C. G., & Dodson, C. S. (2004). Why distinctive information reduces false memories: evidence for both impoverished relational-encoding and distinctiveness heuristic accounts. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 30(4), 787-795.
- Howe, M.L. (1998). When distinctiveness fails, false memories prevail. *Journal of Experimental Child Psychology*, 71, 170-177.
- Hunt, R. R., & Einstein., G.O. (1981). Relational and item-specific information in memory. *Journal of Verbal Learning and Verbal Behavior*, 20, 497-514.
- Hunt, R. R., & McDaniel, M.A. (1993). The enigma of organization and distinctiveness. *Journal of Memory and Language*, 32, 421-445.
- Hyman, I. E., & Pentland, J. (1996). The role of mental imagery in the creation of false childhood memories. *Journal of Memory and Language*, 35, 101-117.
- Israel, L., & Schacter, D.L. (1997). Pictorial encoding reduces false recognition of semantic associates. *Psychonomic bulletin & review*, 4, 577-581.
- Jacoby, L.L. (1991). A process dissociation framework: Separating automatic from intentional uses of memory. *Journal of Memory and Language*, 30, 513-581

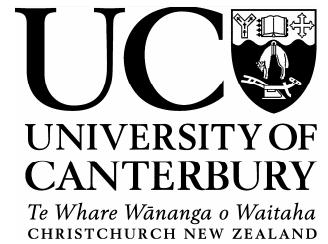
- Johnson, M. K., Hashtroudi, S. & Lindsay, D.S. (1993). Source monitoring. *Psychological Bulletin*, 114(1), 3-28.
- Johnson, M. K., & Raye, C.L. (1981). Reality monitoring. *Psychological Review*, 88, 67-85.
- Kee, D.W. (1994). Developmental differences in associative memory: Strategy use, mental effort, and knowledge access interactions. In H.W. Reese (Ed.), *Advances in child development and behaviour* (7-32) (Vol.25). New York: Academic Press.
- Koutstaal, W. Schacter., D.L. (1997). Gist-based false recognition of pictures in older and younger adults. *Journal of Memory and Language*, 37, 555-583.
- Loftus, E. F. (1997). Creating false memories. *Scientific American*, September, 50-55.
- Loftus, E. F. (2003). Make-believe memories. *American Psychologist*, November, 867-873.
- Loftus, E. F. & Palmer, J.C. (1974). Reconstruction of automobile destruction: An example of the interaction between language and memory. *Journal of Verbal Learning and Verbal Behavior*, 13, 585-589.
- Loftus, E. F. & Pickrell, J.E. (1995). The formation of false memories. *Psychiatric Annals*, 25(12), 720-725.
- Mather, M., Henkel, L.A. & Johnson, M.K. (1997). Evaluating characteristics of false memories: Remember/know judgments and memory characteristics questionnaire compared. *Memory & Cognition*, 25(6), 826-837.
- Payne, D.G., Neuschatz, J.S., Lampinen, J.M. & Lynn, S.J. (1997). Memory for a past that never was. *Current directions in psychological science*, 6 (3), 56-60.
- Potter, M.C., & Faulconer, B.A. (1975). Time to understand pictures and words. *Nature*, 253, 437-438.
- Read, J.D. (1996). From a passing thought to a false memory in 2 minutes: Confusing real and illusory events. *Psychonomic Bulletin & Review*, 3 (1), 105-111
- Riegler, A. (2005). Constructive memory. *Kybernetes*, 34(1/2), 89-104.
- Roediger, H. L., III (1996). Memory Illusions. *Journal of Memory and Language*, 35, 76-100.
- Roediger, H. L., III, Balota, D.A. & Watson, J.M. (2001). Spreading activation and arousal of false memories. In H. L. Roediger, Nairne, J.S., Neath, I & Suprrenant, A.M. (Ed.), *The Nature of Remembering: Essays in Honor of Robert G. Crowder* (1st ed. ed.). Washington DC: American Psychological Association.
- Roediger, H.L., III, Watson, J.M., McDermott, K.B., & Gallo, D.A. (2001). Factors that determine false recall: A multiple regression analysis. *Psychonomic Bulletin & Review*, 8, 385-407

- Roediger, H. L., III, McDermott, K.B. & Robinson, K.J. (1998). The Role of associative processes in creating false memories. In M.A. Conway, S.E. Gathercole, & C. Cornoldi, C. (Ed.), *Theories of Memory* (189-245) (Vol. II). Hove, UK: Psychology Press.
- Roediger, H.L., III, & McDermott, K.B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 803-814.
- Russell, W.A., & Jenkins, J.J. (1954). *The complete Minnesota norms for responses to 100 words from the Kent-Rosonoff Word Association Test*. Minneapolis: University of Minnesota.
- Schacter, D. L., Cendan, D.L., Dodson, C.S. & Clifford, E.R. (2001). Retrieval conditions and false recognition: Testing the distinctiveness heuristic. *Psychonomic Bulletin & Review*, 8, 827-833.
- Schacter, D.L., Israel, L., & Racine, C. (1999). Suppressing false recognition in younger and older adults: The distinctiveness heuristic. *Journal of Memory and Language*, 40, 1-24.
- Schacter, D. L. Norman., K.A. & Koutstaal, W. (1998). The Cognitive Neuroscience of Constructive Memory. *Annual Review of Psychology*, 49, 289-318.
- Schneider, W., & Bjorklund, D. (2001). Memory and knowledge development. In J. Valsiner & K. Connolly (eds.). *Handbook of developmental psychology* (375-403). London:Sage.
- Schneider, W., & Pressley, M. (1989). *Memory development between 2 and 20*. New York: Springer-Verlag.
- Shaffer, D.R. (2002). *Developmental psychology: childhood and adolescence* (6<sup>th</sup> ed.). Belmont, CA: Wadsworth Thomas Learning.
- Smith, R. E. & Hunt., R. (1998). Presentation modality affects false memory. *Psychonomic Bulletin & Review*, 5(4), 710-715.
- Smith, M.C., & Magee, L.E. (1980). Tracing the time course of picture-word processing. *Journal of Experimental Psychology: General*, 109 (4), 373-392
- Storbeck, J. & Clore, G.L. (2005). With sadness comes accuracy; with happiness, false memory. *Psychological Science*, 16 (10), 785-791.
- Theios, J. & Amrhein, P.C. (1989). Theoretical analysis of the cognitive processing of lexical and pictorial stimuli: reading, naming, and visual and conceptual comparisons. *Psychological Review*, 96 (1), 5-24

## **APPENDICES**

- Appendix 1:** Example of a letter to a Principal
- Appendix 2:** Slides from the experiment presented to participants in the picture-encoding condition
- Appendix 3:** Slides from the experiment presented to participants in the word-encoding condition
- Appendix 4:** The 6 lists which comprise 12 semantically related items in the order as read aloud by the researcher
- Appendix 5:** Haunted House Maze
- Appendix 6:** Instructions
- Appendix 7:** Letter confirming ethical approval for research
- Appendix 8:** Parental consent form
- Appendix 9:** Debriefing form

## APPENDIX 1



### College of Science

#### Department of Psychology

Marissa Blakeley  
Department of Psychology  
University of Canterbury  
Private Bag 4800  
Christchurch  
(03) 364 2987 ext 7988

The Principal  
Shirley Intermediate  
Cnr North Parade and Shirley Road  
Shirley  
Christchurch

Dear Mr Fraser,

My name is Marissa Blakeley and I am a psychology research student at the University of Canterbury. I am interested in conducting research with eleven year old children in the Canterbury area, and would very much appreciate the opportunity to work with Year 7 students at your school.

My research entitled *Do children use the same encoding and retrieval mechanisms to reduce false memories as adults? An exploration of the use of the impoverished-relational encoding and distinctiveness heuristic accounts in children* is exploring the ways to reduce inaccurate memories in children. To my knowledge, this has only been explored in adults. If successful, the research could carry valuable theoretical and practical implications in an important area of psychology. It could improve our understanding of the ways that children study and learn distinctive information.

The project involves students studying a series of either pictures or words and then recalling the ones they can remember. Following a short distractor task (a maze) they will be asked to complete a recognition task. Students are to be tested in a classroom with a projector.

With your approval, the students will be given a small reward as a token of appreciation for their participation in the project. This research project has been reviewed and approved by the University of Canterbury Human Ethics Committee. I have developed parental information and consent forms.

I would very much appreciate and enjoy the opportunity to work with you and the students of your school.

Yours faithfully

Marissa Blakeley

Dr Ewald Neumann (Supervisor)

## APPENDIX 2

You will be shown a number of pictures

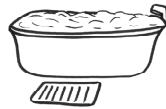
I would like you to study the pictures as carefully as you can because I am going to question you on them later

You will see 72 pictures

Each picture will appear on the screen for 5 seconds

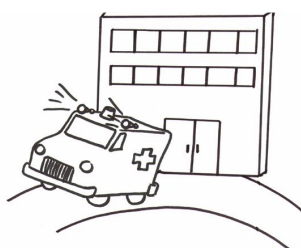
I will speak the name of each picture while you are looking at it

The next slide is a practice trial



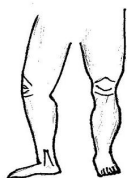
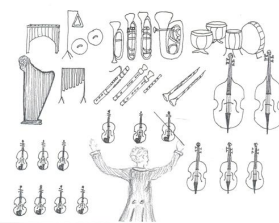
In a few seconds the study items will begin

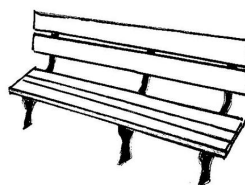
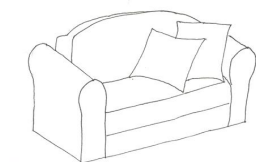
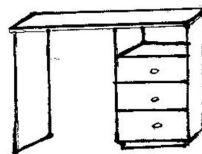
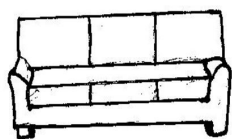


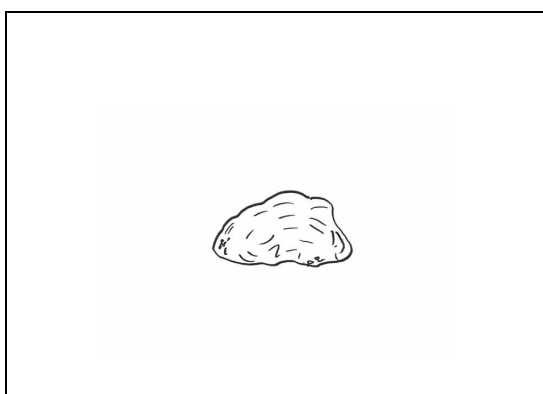
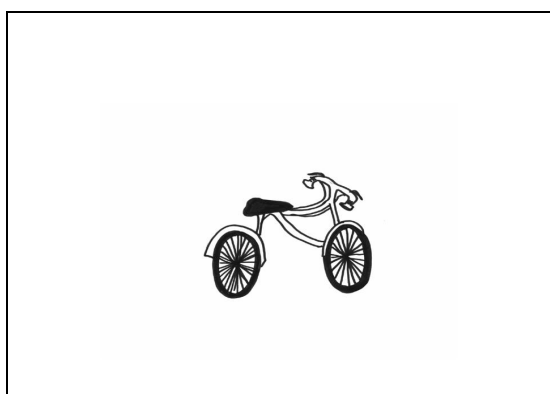
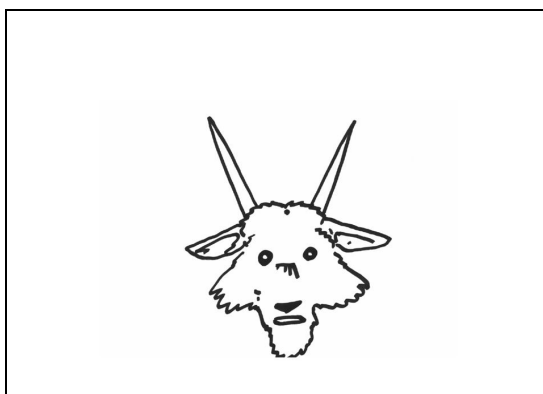
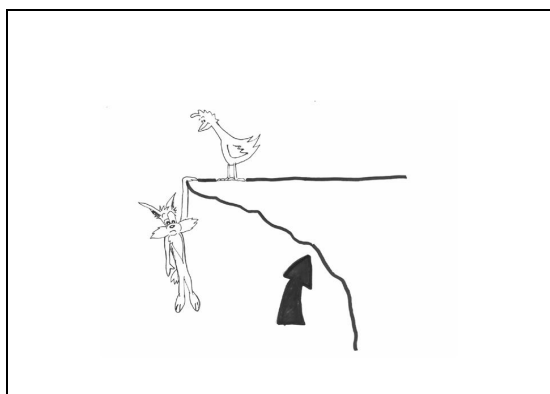
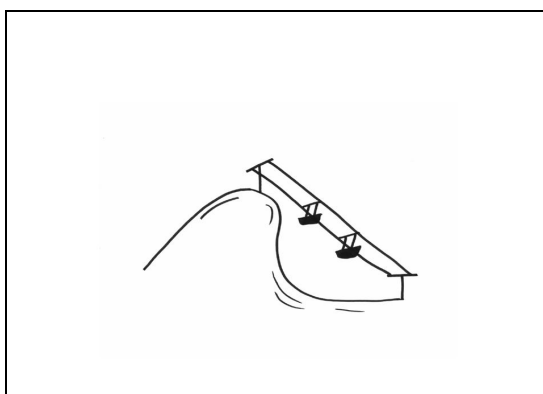
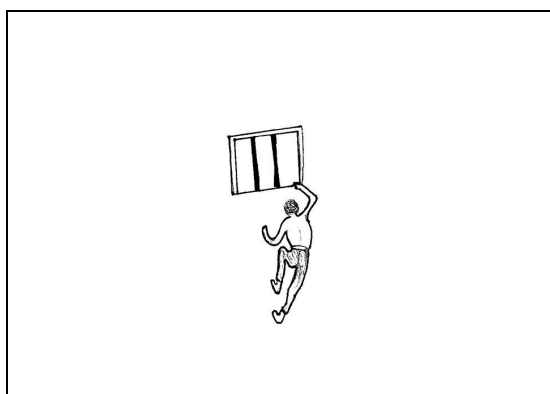
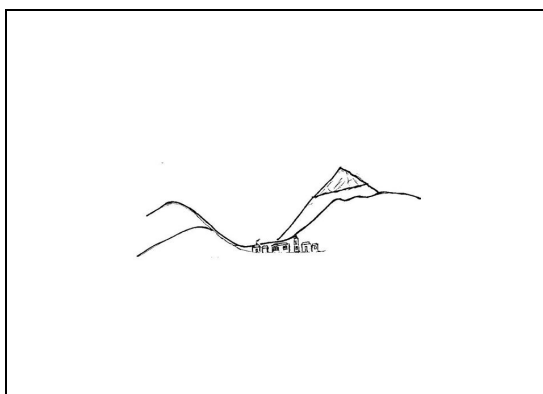
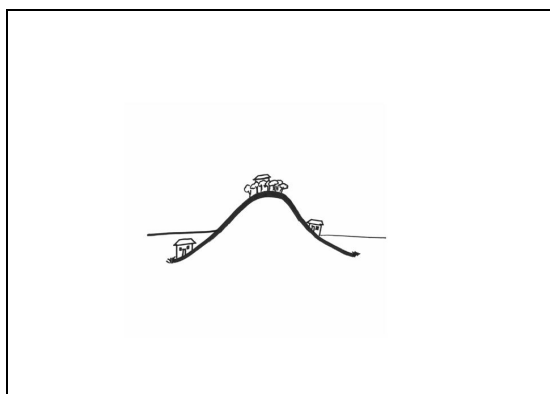


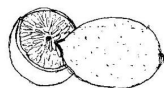
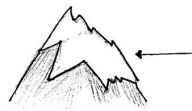
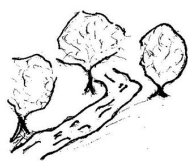


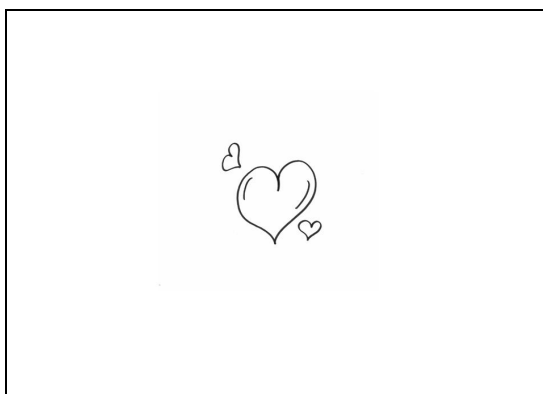
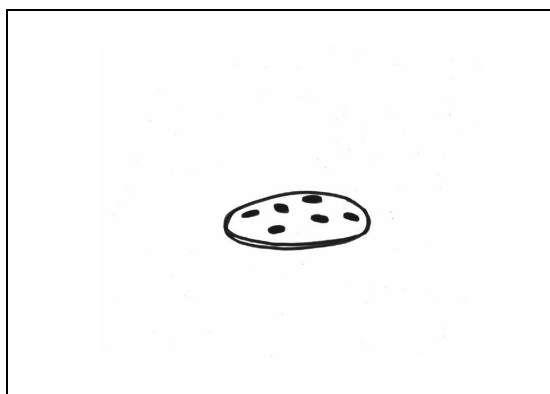
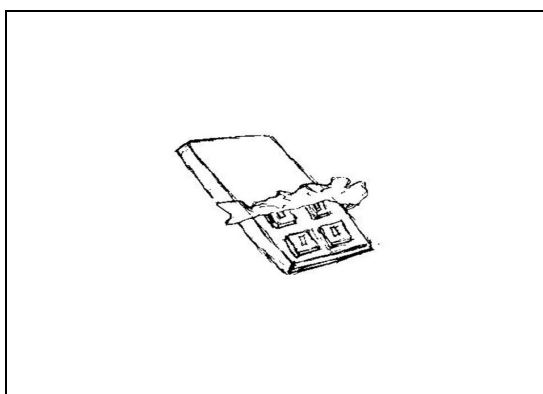
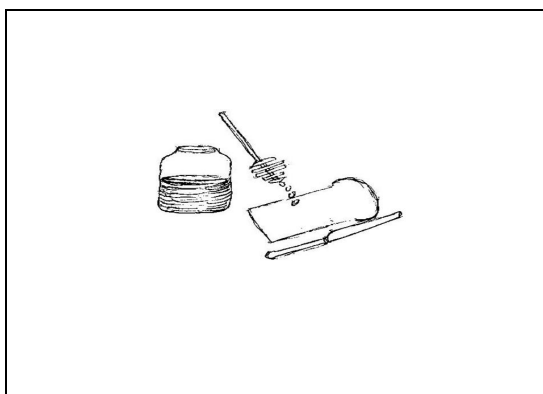
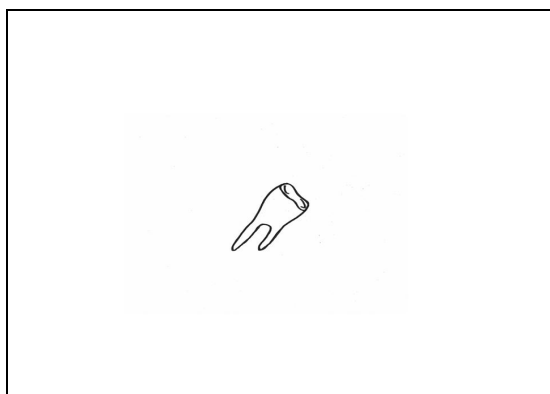




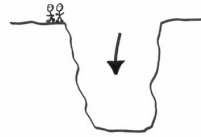












Now I would like you to solve  
the puzzle  
Start at the chimney and try to  
make your way to the back  
door

Please turn over the piece of paper  
on your desk and follow the  
instructions

## APPENDIX 3

You will be shown a number of words

I would like you to study the words as carefully  
as you can because I am going to question you  
on them later

You will see 72 words

Each word will appear on the screen for 5  
seconds

I will speak the name of each word while you are  
looking at it

The next slide is a practice  
trial

bath

In a few seconds the study  
items will begin

nurse

sick

lawyer

medicine



pills

bill

hospital

dentist

patient

office

injection

surgeon

note

sound

piano

sing

radio

band

horn

concert

instrument

jazz

art

orchestra

table

sit

legs

seat

couch

desk

lazy-boy

cushion

sofa

stool

rocking

bench

hill

valley

climb

slope

cliff

goat

bike

rock

stream

snow

ski

cave

sour

lollies

sugar

taste

tooth

honey

fizzy drink

chocolate

cookie

heart

cake

pie

bed

rest

pillow

awake

tired

dream

blanket

snore



nap

deep

peace

yawn

Now I would like you to solve the  
puzzle  
Start at the chimney and try to  
make your way to the back door

Please turn over the piece of  
paper on your desk and follow  
the instructions

## APPENDIX 4

nurse  
sick  
lawyer  
medicine  
pills  
bill  
hospital  
dentist  
patient  
office  
injection  
surgeon  
note  
sound  
piano  
sing  
radio  
band  
horn  
concert  
instrument  
jazz  
art  
orchestra  
table  
sit  
legs  
seat  
couch  
desk  
lazy-boy  
cushion  
sofa  
stool  
rocking  
bench  
hill  
valley  
climb  
slope  
cliff  
goat  
bike  
rock  
stream  
snow  
ski  
cave  
sour  
lollies  
sugar

taste  
tooth  
honey  
fizzy drink  
chocolate  
cookie  
heart  
cake  
pie  
bed  
rest  
pillow  
awake  
tired  
dream  
blanket  
snore  
nap  
deep  
peace  
yawn

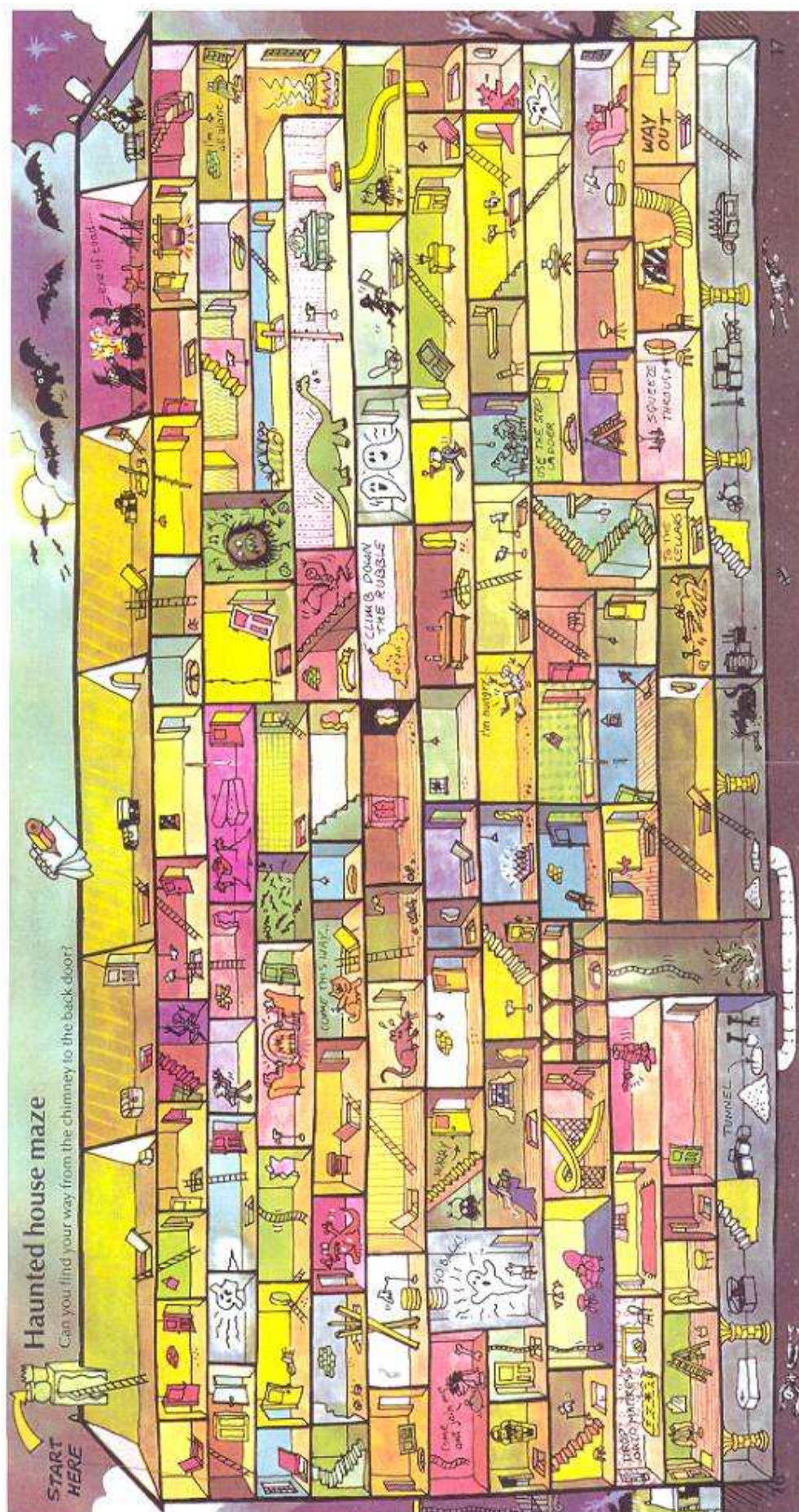
## **APPENDIX 5**

### **“Haunted House Maze”**

**Extracted from:**

**Tyler, J., & Round, G. (1980). *Picture puzzles*. London:  
Usborne Publishing Ltd.**

**Subjects were presented with an A3 greyscale version of  
the Maze, shown in A4 colour on the following page**



## APPENDIX 6

- i) Standard recall (picture condition)
- ii) Standard recall (word condition)
- iii) Inclusion recall (picture condition)
- iv) Inclusion recall (word condition)
- v) Specific recall (picture condition)
- vi) Specific recall (word condition)

i)

**On the piece of paper given to you,  
please write down as many of the  
words describing the pictures as you  
can**



ii)

**On the piece of paper given to you,  
please write down as many of the  
words that were shown to you as you  
can**



iii)

**On the piece of paper given to you,  
please write down as many of the  
words describing the pictures as you  
can**

**Please also write down any words that  
you think of which are related to the  
pictures that you saw. For example, if  
you were shown a list of pictures such  
as *shoe*, *sock*, *toe* and you  
remembered a related word *foot*, you  
would write *foot* down also.**





**Now go through your list of words  
and place a tick next to the words  
which you think were shown to you  
on the computer screen**



iv)

On the piece of paper given to you,  
please write down as many of the  
words that were shown to you as you  
can.

Please also write down any words that  
you think of which are related to the  
words that you saw. For example, if  
you were shown a list of words such  
as *shoe*, *sock*, *toe* and you  
remembered a related word *foot*, you  
would write *foot* down also.

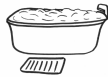


**Now go through your list of words  
and place a tick next to the words  
which you think were shown to you  
on the computer screen**



v)

**Please write down only the names of the pictures that you remember seeing come up on the computer screen. So for example, if you remembered seeing a picture of a bath**



**you would write *bath* on your list and all the other pictures you remember seeing.**

vi)

**Please write down only the names  
of the words that you remember  
seeing appear on your computer  
screen. So for example, if you  
remembered seeing the word**

**bath**

**you would write *bath* on your list  
and all the other words you  
remember seeing on the screen.**

**APPENDIX 7**

Ref: HEC 2005/30

30 May 2005

Marissa Blakeley  
Psychology  
UNIVERSITY OF CANTERBURY

Dear Marissa Blakeley

The Human Ethics Committee advises that your research proposal "Do children use the same coding and retrieval mechanisms to reduce false memories as adults? An exploration of the use of the impoverished-relational encoding and distinctiveness heuristic accounts in children" has been considered and approved.

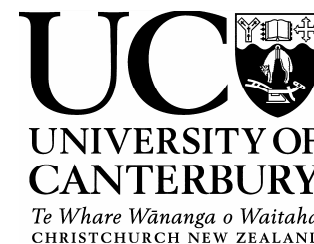
Yours sincerely

Dr Catherine Moran  
*Interim Chair*

## APPENDIX 8

## College of Science

## Department of Psychology



Dear Parents / Guardians,

My name is Marissa Blakeley and I am a psychology research student at the University of Canterbury, investigating the accuracy of memory. My research study will involve children participating in a memory test. They will be shown a series of pictures or words and will then be given a memory test. There is no foreseen harm to the participants and the research will be conducted in school hours. It is not likely to take more than 40 minutes. Your child will be offered a sweet at the completion of the experiment. I would very much appreciate it if you would allow your child to participate in this memory test. This research study is part of a Master of Science Thesis, through the Psychology Department of the University of Canterbury. If you have any queries or concerns about the project please do not hesitate to ask either myself (364 2987 ext 7988) or my supervisor, Dr Ewald Neumann on 364 2987 ext 6964.

The results from the experiment will be held in the strictest confidence and only myself and my supervisor will have access to them. If published, the students' information will remain confidential and anonymous.

Participation in the study is entirely voluntary and if your child wishes to withdraw from the study at any time he or she may do so. Any information relating to him / her will also be withdrawn from the study at that time. This research project has been reviewed and approved by the University of Canterbury Human Ethics Committee.

-----

I have read and understood the above research project and I agree that data concerning my child's response to the memory test may be used for the project. I consent to publication of the results with the understanding that my child's anonymity will be preserved.

I also understand that if I decide at a later date (before the publication of the experiment) that I am not content with this decision, I can withdraw from the project and the information that my child has provided will then be destroyed.

NAME (please print):.....

CHILD'S NAME: .....

CHILD'S CLASS.....

Signature.....

Date:.....

Please tick the box to indicate your preference for treat given at the end of the experiment:

Small chocolate bar (15g) ☐

No chocolate bar ☐

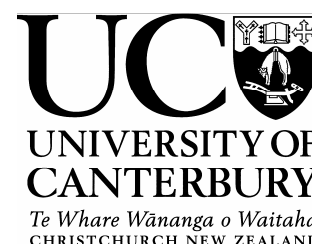
If 'no', please suggest an alternative treat .....

## APPENDIX 9

### College of Science

#### Department of Psychology

Dear Parents / Guardians,



Thank you very much for allowing your child to participate in a study on children's memory and the inaccuracy of memory. The main aim of this study was to determine whether children use the same memory mechanisms as adults to reduce false memories. Your child was presented with a number of pictures or words that were all related to a word that was not presented in the study items. For example, words were presented such as "sour", "lollies" and "sugar" which were all related to the word "sweet". When a child incorrectly remembers the word "sweet" it is noted as a false memory.

This study extends our understanding of the ways that children remember pictures in comparison to words and gives us insight into the way that children can reduce false memories.

Thank you again for assisting in this study. It is greatly appreciated. If you have any questions regarding this study, please do not hesitate to contact either myself or one of my supervisors below.

Sincerely,

Marissa Blakeley

Marissa Blakeley  
Department of Psychology  
University of Canterbury  
Phone 364 2987 ext 7988

Dr Ewald Neumann  
Department of Psychology  
University of Canterbury  
Phone 34 62987 ext 6964

Mr Paul Russell  
Department Psychology  
University of Canterbury  
Phone 364 2987 ext 6170